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SEWALLS FALLS POWER PLANT IN NEW HAMPSHIRE

The Hydro-Electric Plant of the Concord Electric Co.

The hydro-electric plant of the Concord Electric Co., at Sewalls Falls, N. H., is being equipped with two vertical shaft three-phase alternators of the type shown in the accompanying illustration, Fig. 1, each having a capacity of 500 kilowatts and supplying a current of 111 amperes with a frequency of 60 periods and a pressure of 2600 volts. The current is to be utilized for lighting service in connection with other generating installations and therefore these machines must operate at nearly a constant speed of 100 revolutions per minute, even under varying conditions of load and head.

The head of the water supply is low, being only about 16 feet at times and varying to as low a point as 12 feet. In order to meet the conditions in this hydraulic development, the

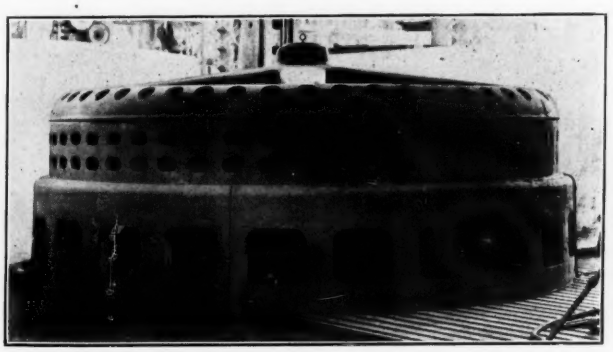


Fig. 1

two 900 horse power wheels, designed by the Allis-Chalmers Co., have three sets of runners and gates complete, as noted in the accompanying illustrations, Figs. 2 and 3. These three sets are arranged on a vertical shaft, one above the other, as shown, and produce the above power with 620 cubic feet of water per second, under a sixteen foot head; or under a twelve foot head develop 625 horse power with 650 cubic feet of water per second.

These turbines are designed to give 80 per cent. of the power of the water at ¾ gate and with full gate 88 per cent., while at half-gate they should give 75 per cent., and a speed of 100 revolutions per minute practically constant is provided for. Draft tubes are provided connecting the tailrace with all three sets of runners, in order to obtain the full energy of the water due to the actual head, regardless of its position on the shaft. A large single tube carries the water away from the two upper runners and a smaller separate tube for each of the lower runners of the two wheels. These Francis central discharge turbines have all three runners of each wheel of the same size, as noted in the illustrations, Figs. 2 and 3, as well as the same capacity and form, but they do not all discharge in the same manner. The middle runner discharges upward and the upper and lower runners discharge downwards, so

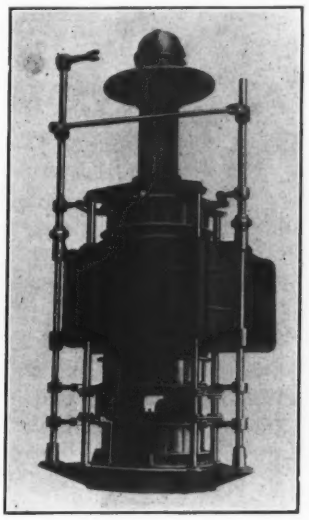


Fig. 2

that the two upper runners are practically balanced from their reactions; while the lower runner tends to lift the weight of the revolving portions of the wheel and the revolving field of the alternator, which has 72 poles, carrying about ⅓ of the weight of the rotating parts.

The governors are of the self-contained oil pressure hydraulic type located on the generator floor, and with a variation of 25 per cent. in the load, are designed to allow not over 2 per cent. variation in speed in 1.5 seconds, while with a 50 per cent. load variation the speed should not vary over 4

per cent. in 2 seconds. The permissible speed variation under a change of load of 100 per cent. is to be not over 8 per cent. in 3 seconds and not over 6 per cent. in 2.5 seconds for a change of load of 75 per cent. on the turbines and alternators.

The rotor shafts are directly coupled to the shafts of the turbines, forming the upper parts of the turbine shafts, the weight of the rotors being carried by the thrust bearings and the upward thrust of the lower runners. The stator parts of the alternators are mounted directly over the turbines on the generator room floor, on cast-iron rings installed on the foundations. These machines are of the Bullock type, the armatures having three-phase windings tested to 5000 volts, while the field coils are tested to 1500 volts, the normal exciting current being 120 volts.

Motor generator sets are provided for exciting the large alternators, 75 horse power induction motors being employed directly coupled to direct-current dynamos of 45 kilowatts capacity. These motor generator outfits operate at a speed of 680 revolutions per minute, the induction motors operating directly from the 60 cycle, 2600 volt three-phase circuits in the power station.

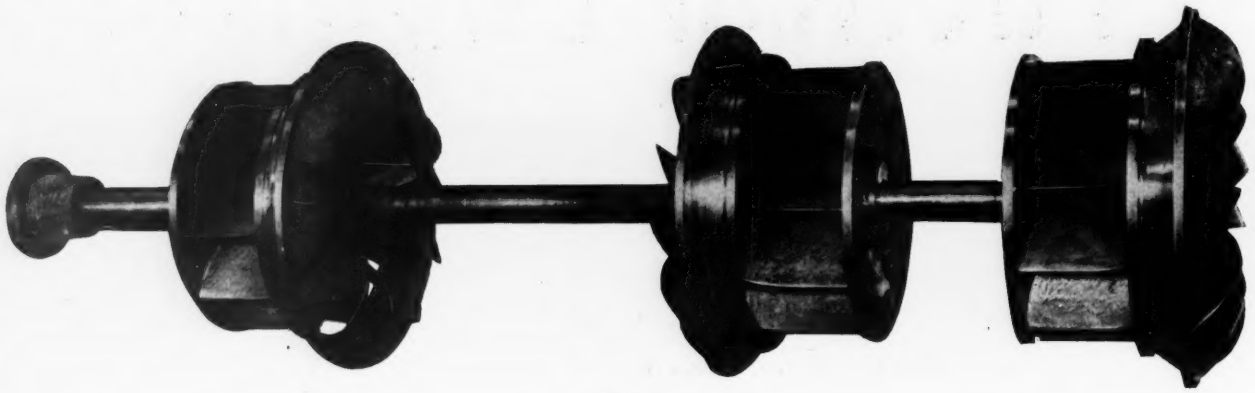


Fig. 3

The unique part of this plant is the turbine installation, which is so designed with the three runners as to supply the necessary power and constant speed under the variable condition of a head varying from 12 feet in times of flood when the water backs up in the lower channel, reducing the working head during such periods to 16 feet, which is available under normal conditions.

OPERATING COMPOUND DYNAMOS IN PARALLEL

By A. C. Kelly.

When connecting two compound continuous-current dynamos in parallel, the perfect understanding of the connections and the method of throwing them in or out of circuit will often obviate difficulties which might be encountered when operating them.

Fig. 1 is a simple diagram of connections for two compound wound continuous-current dynamos in parallel, and will tend to illustrate the method of operating same.

In the diagram, the machine terminals are marked + and —, E is the equalizer connection, S the series field coil, S′ the shunt field coil, 1, 2, 3 are single-pole, single-throw knife switches; A is ammeter; Ba circuit breaker; Va volt meter; A.S. the main ammeter shunt; M.A. the main ammeter; G.L. ground lamps; L′ a pilot lamp; and E the equalizer bus bar. For the sake of clearness, fuses for pilot lamp, volt meter, etc., have been omitted in the diagram.

In connecting two or more compound-wound machines to operate in parallel, it is necessary to first see that you have your equalizer connection in the right place, namely, between the terminal of the series field coil and the brush that the series field coil connects to. Then see that the polarities of like terminals of the machines are alike, and that you have the like terminals of each machine connected to the same bus bar. See that you have the leads from each machine that comes from the series field winding connected to the same bus bar, and that the other terminals of each machine connect to the other bus bars.

The wiring of the switchboard should be such that the ammeter is inserted in the lead that comes direct from the brush; the lead that switch 3 is connected to in the diagram. Never connect your ammeter in the lead that comes from the series field winding, as a part of the current may flow through the equalizer, and consequently the ammeter would not indicate the full output of the machine.

Before attempting to run the machines in parallel, try each machine separately to see that it generates properly and that the polarities are right.

Sometimes in connecting up a compound-wound machine, the series field terminals might be reversed. In such an event, the machine will generate its maximum E. M. F. with no load, but, as the load is applied, the voltage will drop. This is due to the fact that the current flowing through the series field coil tends to neutralize the shunt field, instead of aiding the latter, as under proper working conditions.

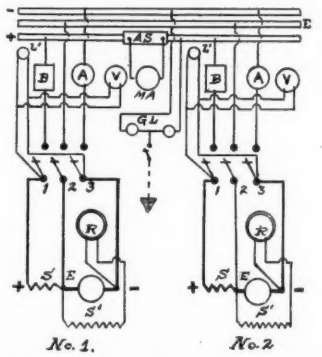
Let us assume that No. 1 machine is in service, and that it is desired to run No. 2 machine in parallel with it. First close the equalizer switch (switch 2), and switch 1, which is in the lead that the series field terminal is connected to and

which is of the same polarity as the equalizer. Now with your rheostat, bring the machine up to voltage. It is well to adjust the voltage about two volts higher than the machine you are going to throw in parallel with. Having done this, close the other line switch (switch 3), which will allow the armature of No. 2 machine to take part of the load. The voltage being just a little higher on No. 2 machine, it will probably not take its share of the load, but can be made to do so by increasing the field excitation by means of the rheostat, or, if it takes too much load, decrease the field excitation a little.

In throwing two machines in parallel, it is necessary to go by the ammeter entirely until you have the load properly balanced or divided between the two machines; then if your voltage is too high or too low, change the rheostats of both machines together so as not to disturb the distribution of the load between the machines.

In taking a machine out of parallel, the above instructions should be followed in the reverse order, that is, the field excitation should be decreased until the machine that is coming out is carrying very little load, then switch 3 should be pulled first, which was the last switch thrown in when putting the machine in parallel, the rheostat should then be turned in, and the equalizer and other line switch opened.

In operating machines in parallel, the above instruction is usually all that is necessary, providing the machines are ex-



Connections for Two Compound-Wound Dynamos in Parallel.

actly the same, that is, providing the machines are of the same capacity and make, but if the machines are of different capacities, and possibly different makes, a number of other matters must be looked after. For instance, the machines should be tested alone and be adjusted by means of shunts, so that each machine will over-compound the same percentage. Then, the resistance of the series field and the lead that connects the end of it to the equalizer bus bar should be the same, if the machines are of the same capacity. If the machines are of different capacities, the resistance should be inversely proportional to the current capacity of the machines. That is, if the machine produces twice as much current, its series field coil and the lead that connects it to the equalizer bus bar should have one-half the resistance of the other machine. If the resistance is not inversely proportional to the current capacity of the machines, it can be made so by introducing a few feet of extra conductor in the lead from the series field coil, and the equalizer bus bar of the machine with too little resistance, being sure to use conductor of the same cross section as the main dynamo leads.

Care must be taken not to use too small a conductor for the equalizer connections. If two machines are used, it should be able to carry at least one-half the full current of one dynamo, and if more machines are used, it should be still larger.

In the proper operation of electric machinery, cleanliness is paramount, and, under no circumstances should an electric machine be allowed to run in a filthy condition. The machine should be wiped down after each run, and, when not in service, should be carefully covered over with oil-cloth to prevent moisture and dirt from settling on it. Particular attention should be paid to the commutator and brushes of continuous-current machines, as those are the vital parts of same, and should be kept scrupulously clean.

When Electricity is Cheap.

Looking forward toward the time when the cost of electric power will be much cheaper than it is today, a writer in Cassier's Magazine indulges in some prophecy concerning the effect this will have upon everyday life in America.

Among other things, he thinks the present methods of refrigeration will be revolutionized, apropos of which he says: "Already miniature electric refrigerating plants have been designed, whose operation is absolutely automatic. These plants have thus far been successfully installed in a number of places, and the reduced cost of power will cause their adoption to a great extent, not only by the larger consumers, as at present, but also in private residences and apartments.

"The push-button elevator is already found frequently in the more elaborate residences. The reduced cost of power will not only stimulate the use of these elevators, but will tend to the adoption of escalators or moving stairways, so arranged that it will simply be necessary to turn a switch at the bottom of the stairs in order to ascend to the top. Automatic arrangements can be provided so that when the person leaves the stairway, the current will be instantly cut off.

"Apartment buildings of the future will have every possible contrivance for increasing the ease and comfort of their tenants. The old bugbear of 'washing and wiping dishes' will be entirely removed, for each apartment will be provided with an electric dish-washing machine, which, with the aid of the hot water faucet, will automatically perform the operation. The future apartment building will be constantly supplied with pure air, filtered and washed by modern and improved methods. The serving of meals will be largely simplified by elaborate systems or dumb waiters and signaling devices, so that the guest in an apartment building or hotel can have almost any dish served automatically without unnecessary delay by simply pressing a given button.

"The reduced cost of power will be felt in every line of industry, and all lines of manufacture depending upon machinery for their product will be in a position to make lower prices on their goods. The old problem of three meals a day will be largely simplified by the use of electric sauce pans and other devices, which can be maintained at varying temperatures by throwing a switch in different positions.

"The reduced cost of electricity will also have a marked effect on the exterior appearance of large cities. Myriads of lights, blazing along the most prominent thoroughfares, will turn night into day, and the standard of street lighting, which is already several times in advance of what it was 20 years ago, will be correspondingly advanced.

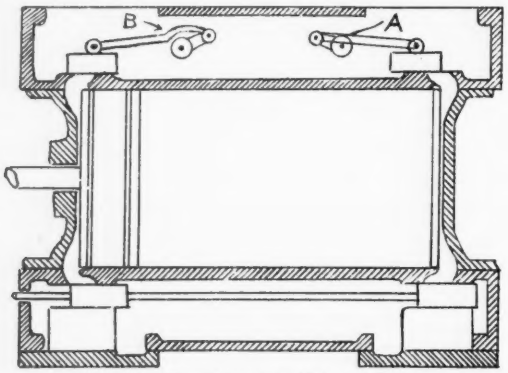
STOP, LOOK AND LISTEN!

Three Precautions Necessary When Changing the Setting of the Valve.

By E. C. Taylor.

In tracing out the various defects in engineering troubles, it is surprising to note how much trouble arises from the action of the valves or the improper setting of them. An engineer will take some cards off his engine and owing to some little defect in the card, will decide to fix it on Sunday. When that eventful day arrives, the valves are changed and set over. Upon starting up on Monday morning, he is surprised to hear the old engine pound and thump at a great rate. As the engine may have been running fairly quiet before the adjustment, he feels worried a great deal, especially if he is a young engineer trying to make a reputation, or if he is a new engineer. In either case, it is exasperating and it seems to reflect on his ability. Possibly he may have to change the engine so that it will have more lead or possibly more lap and compression.

While I respect a man for his energy, it must be remembered that there are engines which may take a fairly good card and still not be in good condition to run. When an engine has been in operation for a number of years, it gets worn to a certain condition of affairs and when the valves are



Troubles Experienced in Valve Setting.

changed to operate at a different point, trouble is often experienced.

For instance, suppose that owing to lack of time a wrong adjustment was made, so that the release does not occur till after the crank had passed the centre, which naturally makes the admission late. What would be the consequence? The piston must be dragged back against the steam by the momentum of the flywheel, thus transferring what looseness there may have been in the bearing or boxes (and there is some in all cases, as it is impossible to run them perfectly tight without heating). If any one of our engineering friends doubts this statement, let him have his assistant work the engine back and forth while he feels the pins or bearings and I think he will quickly be satisfied as to the truth of my assertion.

As stated, the looseness is transferred to the opposite direction in which the engine is running and when the steam that is compressed in the cylinder is released and live steam admitted to the opposite side of the piston, the whole load is suddenly thrown on to the other side of the bearings with a pound that is scarcely equalled by a sledge hammer.

Engineers, and especially young ones, should be careful before altering or attempting to set valves. Study the situation over carefully and see what the results would be before the alteration is made. Many a good bearing has been ruined by keying up when the trouble is finally traced to the valves. If, however, it is decided to make the alteration, after it is made, look everything over carefully and turn the engine by hand if possible, noting the various positions of the valves as regards lead, cut-off and release. Don't be in too big a hurry and remember that it is very difficult to locate a knock that is caused by an improperly working valve.

A case of valve interference, and the result of not looking things over thoroughly, came to my attention recently. An old engine was being overhauled to a certain extent during a week's shut-down. Among other things, new links for the steam valves were installed. The steam valves of this particular type of engine were of the flat gridiron type, the steam chest being at the top of the cylinder and the exhaust chest at the bottom. These valves lay flat on the ports and are operated by means of a rock shaft that carries tappet blocks which in turn connect with toes on a sliding bar that derives its motion from the eccentric. The rock shafts are connected to the steam valves by means of a pair of links inside the steam chest. These links are held to the pins on the valves by a ¼-inch bolt which passes through both links with a split key in the end of the bolt. These links, owing to some former adjustment, were made too long, thus carrying the valves altogether too far over the port, or, in other words, the valves had too much lap. This necessitated the eccentric being set so as to commence to move the valve when the crank moved half-stroke, in order that the proper lead would be acquired when the centre was reached. This large lap also affected the cut-off, for when the engine was open at half-port, the engaging points of the tappets were released owing to their having reached the extent of their travel, which allowed the dash-pots to close the valve.

This state of affairs reduced the power of the engine 50 per cent., for just as the engine had commenced to get its full supply of steam it was suddenly cut off again. New and shorter links were made, the eccentric and the toes of the sliding bar being adjusted so as to give a full port opening. After this had been done, the covers were replaced.

As it was late at night and no steam was obtainable, the engine was left until the next morning, which was the appointed time to resume operations. After steam had been blown through the engine, the following morning, it was started. The engine took steam all right—but with what result? It pounded and slammed in the chest at an alarming rate and to add to the confusion, the boiler, which had been previously large enough, was not in it for a minute in keeping up steam. The exhaust seemed to have one straight blow.

The engineers struggled along until noon when the covers were removed and it was found that the links were striking the rock shaft, as at A. The rock shaft was constructed as

shown in cut and opened towards the centre of the cylinder. This carried the link over the rock shaft and owing to the circular sweep of the part of the rock shaft that carried the links, it brought them down on the body of the shaft, thus lifting the valve off the seat and allowing steam to blow underneath the valve which, when it closed, came back on the seat with a fearful slam.

Owing to the change in the position of the toes, it had been necessary to change the position of the tappet block on the rock shaft, which caused a different sweep of the rock shaft from that which had previously taken place. The links were therefore taken out and forged with an offset in them, as shown at B. This allowed the links to travel over the rock shaft without striking. After this was done, no more trouble was experienced.

It was just another case of hurry, coupled with a little carelessness in not looking everything over before replacing the steam chest cover and in not pausing to stop, look and listen!

Facts about Direct-Current Motors

By Jacob Glogan.

A motor is a machine for converting the electrical power supplied into mechanical power at the pulley. There are three kinds of direct-current motors, namely: series, shunt and compound. The principle of the motor depends upon the fact that the magnetic field attracts the wires on the armature at one side and diametrically opposite repels it; therefore, the two reactions tend to rotate the armature. This tendency to rotate is called *torque*. To obtain continuous rotation of the armature, the current in the armature coils must be reversed at the instant the turning effect ceases. This is done by the commutator.

The direction of rotation of a shunt motor is the same as that of a shunt dynamo, since the current passes through the field and armature the same way in each case. In a series motor, the direction is the reverse of a series dynamo.

The armature of a motor, when revolving in a magnetic field, cuts the lines of force issuing therefrom, therefore generating an electro-motive force which is opposite the electro-motive force which is applied to the motor. This electro-motive force is called the counter electro-motive force and tends to equal the impressed electro-motive force. At no load the motor takes very little current, owing to the fact that the counter electro-motive force very nearly equals the impressed electro-motive force. The relation between the current in the armature and counter electro-motive force is shown by the formula

$$\text{Current in Armature} = \frac{\text{E. M. F.} - \text{Counter E. M. F.}}{\text{Resistance in Armature}}$$

When a motor takes on load, the speed begins to decrease, but as it tends to keep a constant speed, the motor requires a greater current. The torque of the motor increases with the current, hence the following law: "The torque is directly proportional to the current." The advantage of counter electro-motive force is that it regulates the current without absorbing the electrical energy, as the rheostat does.

Before selecting a motor, the class of work it is going to do must be considered. There are three general classes of work that require different torques and speeds: for instance, when a motor is running a crane, it must run with constant torque at variable speeds, since the load is always practically constant; when a motor is connected to shafting for machinery or when direct connected, it must run at constant speed and variable torque; and in street railway work there is the third class to be considered, which is the combination of the above two cases, or variable torque at variable speeds. When a motor has to do the first and third class of work, a series motor is used, and when a motor has to perform the second class of service, a shunt motor is used.

There are two general ways of regulating a motor; in shunt wound motors by inserting resistance in the armature circuit, and in series wound motors by varying the field strength, the rule for the latter being that the speed of the motor increases as the field strength is decreased and *vice versa.*

The efficiency of a motor is equal to the output divided by the intake. The energy furnished to a motor is easily found or easily measured and from this must be subtracted the losses in the motor to obtain the available energy. The power developed by a motor equals the counter electro-motive force times the current intake. The power of a motor increases as the counter electro-motive force decreases until the counter electro-motive force is equal to one-half the applied electro-motive force, the maximum work being done when the motor arrives at that state.

In starting shunt motors, always be sure that the fields are first excited, since without field excitation, the armature could not generate its counter electro-motive force and would take an excessive current from the line. The self-induction and resistance of the armature and fields of a series motor tend to check the sudden rush of current through it, so that in some cases the series motor may be directly-connected to the mains without serious or injurious effects; usually, however, some resistance is connected in the motor circuit and gradually cut out. The speed that any motor attains is such that the sum of the counter electro-motive developed and the voltage drop in the armature (resistance of armature $\times$ current flowing through it) equals the applied electro-motive force.

Up to the present time, the effect of sparking at the brushes of motors due to changes in loads, has not been entirely done away with, although the new interpole motor has made a very marked improvement in that line. As is well known, sparking is due to self-induction and armature reaction. The resistance of the brushes does away with some of the sparking, but not all. Many methods have been tried but the most successful is one that provides a magnetic field independent of the main field of the motor. This is done in the interpole motor by inserting auxiliary poles which are small compared with the main poles and are placed between the latter, the auxiliary poles being provided with coils which are connected in series with the armature, so that all the current taken by the armature flows through the coils of the independent field which are so proportioned and arranged as to give the proper field for commutation. This type of motor maintains constant speeds at all loads, it operates without sparking and can be reversed without injury.

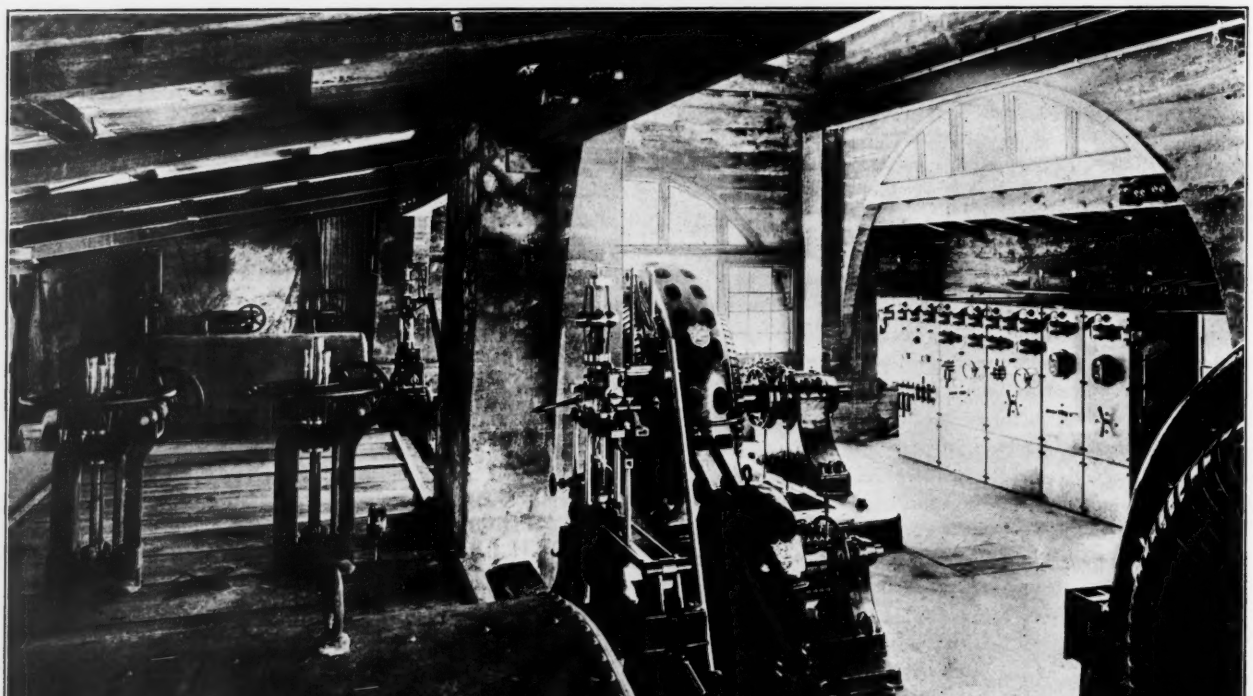
A NEW CALIFORNIA ELECTRIC PLANT

Hydro-Electric Power Station near Junction City

The accompanying illustrations show the interior of the generator and turbine room of a new hydro-electric power station recently constructed on the Trinity River, near Junction City, California, at an elevation of nearly 1500 feet above the sea-level.

The plant was constructed with great difficulty on account of the great distance from a railway and the very steep and severe mountain roads which had to be traversed across Oregon, Trinity and Brown's Mountains. The heaviest machinery, weighing 9 tons, had to be hauled up steep grades over 60 miles, a score of horses being required for transporting the dynamos, turbines and transformers to the power station.

The water is carried from the forebay, which is 60 feet long, 14 feet wide and about 10 feet in depth, by two penstocks, over 1000 feet in length, to the turbines, under a total head of 604 feet.



View in Power House showing Water Wheel Housings, Generators and Switchboard

The water is supplied to the plant from the Canon Creek, which drains an area of over 50 square miles, much of which is nearly 2 miles above the sea-level, with perpetual snow in many places. The water is conducted from a small dam used to divert the water by ditches. About a mile of flumes, varying from 50 feet to over a thousand feet in length, and a tunnel nearly two thousand feet long carry the water to the power house, which is located about a dozen miles from Weaverville and nearly 60 miles from Eureka, which is one of California's principal coast cities in the northern part of the State.

About 80 cubic feet of water per second can be carried through the ditches, the tunnel and a score of flumes having a total length of nearly 8 miles, with an average fall of a trifle over 9 feet per mile. The tunnel is about 5 feet by 6 feet in cross section and supplies sufficient water for three Pelton water wheels of about 1000 horse power capacity each. Two units have already been installed, each consisting of a 44-inch water wheel directly coupled to a Bullock 750 kilowatt three-phase generator of the revolving field type noted in the illustration.

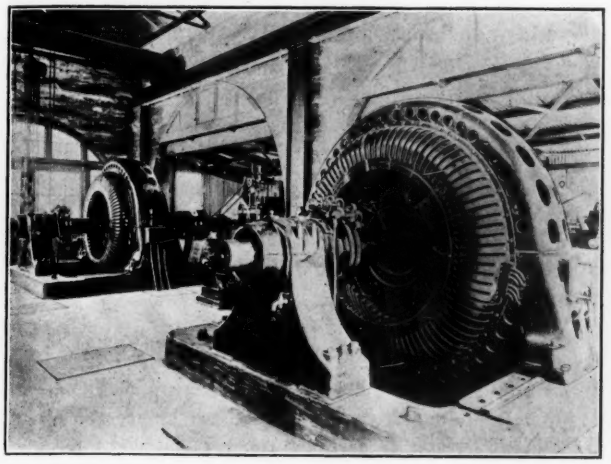
The penstocks are each 3 feet in diameter at the top, reducing in size to 2 feet 4 inches and then dividing into two pipes 1½ feet in diameter, all of which is anchored and enclosed in masonry. The total effective head is about 600 feet, making the pressure about 260 lbs. at the nozzles of the water wheels.

The Pelton wheels have deflecting nozzles and operate the alternators at a speed of 500 revolutions per minute. They are capable of driving these three-phase machines at 1000 kilowatts or about 25 per cent. overload, the normal capacity of the machines being about 750 kilowatts. These alternators are of the Bullock type, constructed at the shops of the Allis-Chalmers Co., and have a frequency of 25 periods per second, supplying a current of 2200 volts pressure.

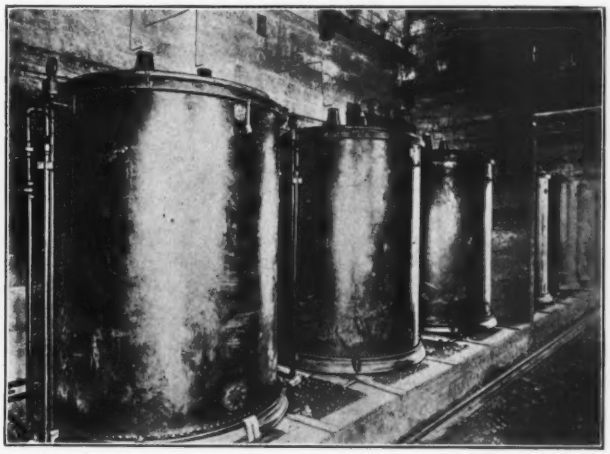
The speed of the generators is held very nearly constant by Lombard oil governors, the oil pumps being driven from the main Pelton wheel shafts by belt transmission. It is stated that no difficulty is experienced with these governors in synchronizing the alternators under the existing load conditions, although no switchboard speed control mechanism is utilized. The water is discharged from the wheels into the Trinity River through a tailrace nearly three hundred feet long and over 6 feet wide cut through the bed rock.

The exciters are belt-driven machines from the alternator shafts, supplying a direct current of 125 volts, each machine having a capacity of 45 kilowatts. The current is conducted from the alternators to seven Bullock step-up transformers, connected in delta fashion on the low-pressure side at 2200 volts, and with star connection on the high-pressure side at 30,000 volts for the transmission service.

The transformers are 300 kilowatt oil insulated machines of the water-cooled type arranged in two sets of three in each group, an additional transformer being provided for reserve. The transformer house is a concrete building about 52 feet long and 13 feet wide and is provided with a track at the proper elevation, so that a transformer can be rolled out of place on to a car and another connected in a short time. The transformers are installed on rollers which rest on rails set in the concrete piers. The transmission line is about 65 miles in length, extending to Eureka.



View in Power House showing Two 750 K. W. Alternators.



Transformer House showing the Oil Filled Water Cooled Transformers.

PRACTICAL HINTS ABOUT INDICATOR CARDS

By Wm. Kavanagh.

The ability to analyze an indicator card leads to important results not only in discovering improper valve setting, small steam ports and pipe connections, but in determining the economical operation of the plant. Every engineer should understand the indicator card thoroughly, for how can a man consider himself an engineer without a knowledge of this science? This question is asked in all faith, as it should be remembered that this knowledge is absolutely essential to the correct operation of the plant. From time to time, articles have appeared in this paper tending to illustrate the indicator and its application and the clear style and simple way in which they were written enabled any one with even a limited education to grasp the principles.

There is one thing, however, that may be emphasized, and that is the correct reading of a card after it has once been taken. It will be understood that an indicator card is a photograph of the action of the steam in the cylinder and if we learn to read this photograph or diagram, as it is technically called, the time the steam was admitted, cut-off, expanded, exhausted and compressed will be known. The student should remember that there are five principal points to be considered: Admission, cut-off, expansion, exhaust and compression.

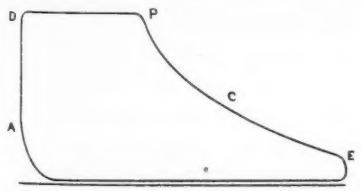


Fig. 1

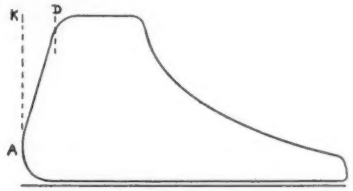


Fig. 2

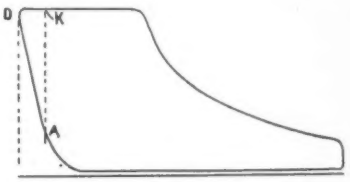


Fig. 3

The principal desire in the use of the indicator is to have the practical diagram coincide with the theoretical card, but owing to the imperfections in the mechanism of the engine and the fact that the steam loses heat in expanding, this

desideratum cannot be obtained; nevertheless, a good diagram should follow closely the lines of a perfect card.

What the practical man needs to know about his diagram is as follows, (freak or humbug cards not considered): First, the back pressure line should be parallel with the atmospheric line and the distance between them as small as possible when the engine is running non-condensing; secondly, the admission line should be vertical to both back pressure and atmospheric lines; thirdly, the steam line should be parallel to both these lines; fourthly, the point of cut-off should be sharp and well defined; fifthly, the expansion curve should conform as closely as possible to the theoretical curve; sixthly, the exhaust curve should have no upward tendency; seventhly, the compression curve should begin about $^{11}/_{12}$ths of the stroke and gradually rise and coincide with the admission line.

Fig. 1 is a card that is seen in everyday practice and can be obtained in any well designed engine of the slow-speed type. The point of cut-off at P is sharp and the exhaust curve at E is of the proper form. It will be noticed that the compression curve begins at about $^{11}/_{12}$ths of the stroke and ends in the admission line about $^1/_3$ its height, as shown at A. The distance between the atmospheric and back pressure line is not over 1½ pounds pressure. The admission line AD is vertical to the atmospheric line and the steam line DP is parallel to the atmospheric line. The expansion curve PCE is fairly accurate and the whole card denotes good practice and shows an intelligent application of the indicator. It will also be noticed that the point of cut-off occurs at about ¼ of the stroke, which point is considered the most economical in general practice.

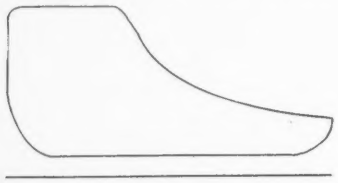


Fig. 4.

The card shown in Fig. 3 is just the reverse of that shown in Fig. 2. The admission occurs too early and instead of AD coinciding with the vertical line at A, it falls the distance KD from it. The distance KD, taken proportional to the length of the card, will determine where the piston was when the port was opened for admission. If the distance KD be $^1/_{12}$th the length of the card and the stroke of the engine is 36 inches, then the piston has travelled 33 inches of its stroke when the port opened for admission; that is, the port opened while 3 inches of the stroke remained uncompleted.

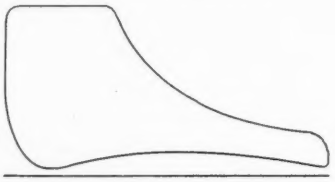


Fig. 5.

Referring to Fig. 4, there are two main objections to the card. One is the excessive back pressure and the other is the exhaust curve, which shows that the exhaust does not open soon enough. Whenever such cases as shown in Figs. 2, 3 and 4 arise, waste of fuel will occur, the only remedy being to have the valves properly set, which will eliminate all unnecessary waste and the engine will run smoother, giving less trouble and in all probability will require less oil and attention.

The case of a leaky piston is shown in Fig. 5, the back-pressure line showing a decided drop, as well as the expansion line. The remedy in this case will be to expand or set out the piston packing rings or if the cylinder is in bad condition, it will have to be rebored.

The case where one end of the cylinder is doing most of the work is shown in Fig. 6. In order to have both ends of the cylinder do an equal amount of the work, the point of cut-off in both ends should be as near equal as possible. The mechanical difficulty of knowing the "angularity of the connecting rod" enters into this problem and prevents an equal steam line on both cards. The crank end of the cylinder also loses a certain amount of its volume, owing to the piston rod, and for these reasons, the lead on the crank end is slightly greater than on the head end. This is especially true on large vertical marine or stationary engines.

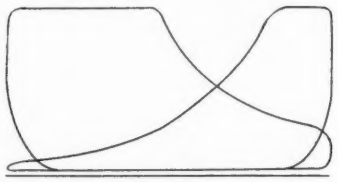


Fig. 6.

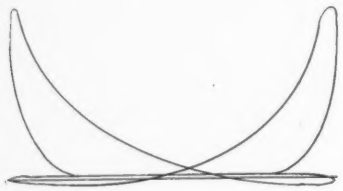


Fig. 7.

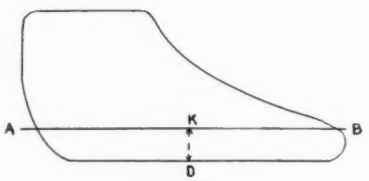


Fig. 8.

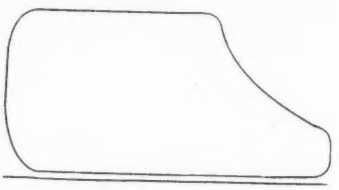


Fig. 9.

Referring to Fig. 2, the admission line AD falls from the vertical line AK and in this case we have what is known as late admission. The distance of the point D from the vertical line will bear the same proportion to the length of the card as the amount the piston travel in the cylinder will bear to the length of the stroke before the valve opens for admission; in other words, if the distance KD is $^1/_{12}$th the length of the card, the piston will have travelled $^1/_{12}$ of its stroke before the steam port is opened, so that if the stroke of the engine was 36 inches, the piston would have travelled 3 inches before the steam port opened full. This is an everyday occurrence where ignorance of the indicator predominates.

The card shown in Fig. 7 is what is known as a friction card. This is a card which shows the amount of power required to run the engine alone. After a friction card is obtained, it should be figured out and the amount of horse power obtained subtracted from a "working card" in order to obtain the horse power available for useful work.

Cards taken from a compound engine are termed high-pressure and low-pressure cards, the names being taken from

the names of the cylinders. If there is an intermediate cylinder, the card taken from it is called the intermediate card. In general, a card receives its name from whichever cylinder it is taken.

A high-pressure card taken from a compound engine will have the appearance of a card taken from a simple engine, with the exception that the distance between the atmospheric and back pressure lines will be greater. Fig. 8 shows a card taken from a low-pressure cylinder, the line AB being the atmospheric line and the distance KD, measured by the scale of the spring, shows what amount of vacuum is available. When great power is required in an engine, the point of cut-off may be carried to ¾ of the stroke, in which case little expansion is obtained and the engine is very uneconomical. Such a card will have the appearance of Fig. 9.

Relation of Load-Factor to the Evaluation of Hydro-Electric Plants

At the recent meeting of the American Society of Electrical Engineers, Mr. S. B. Storer read a paper entitled, "The relation of load-factor to the evaluation of hydro-electric plants," in which he shows that with few exceptions, the value of any hydraulic plant is dependent upon the load-factor. The paper in part follows:

The value of any water-power plant is due primarily to its earnings dependent on the market for its output, and secondarily to the type and quality of the apparatus installed and of the development as a whole. In the case of plants that are in process of development, or that are only partly loaded, the value is, of course, more or less of a speculative nature, and is estimated on the basis of possible and probable income. Prospective earnings, as well as actual earnings, necessarily rely on selling an amount of power equal to the maximum or the ultimate capacity of the development; and the number of

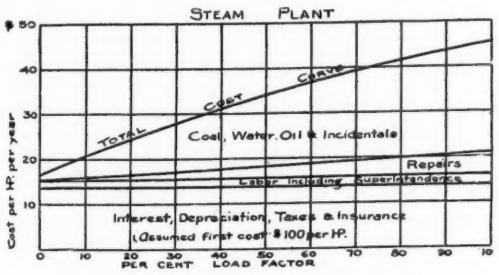


Fig. 1.—Cost of Energy from a Steam Plant.

hours per day during which the maximum capacity can be utilized is a definite factor in deciding the price at which the power is sold. This is equivalent to saying that earnings depend on the load-factor, where that is considered as the ratio between the average output of the station and its rated capacity. Carried to the extreme, zero load-factor means no market for the power and consequently no value to the plant. The type or class of installation, whether good, bad or indifferent, does not affect such valuation, for the reason that the plant represents nothing as to earning power.

Few large hydro-electric plants exist today the values of which are not to a considerable extent speculative or problematical, owing to their operating at an output somewhat below their rated or their ultimate capacity. In some cases it has been so difficult to find a market for power that plants have passed through re-organization with a resultant heavy loss to investors, and still are unable to show any profit or even to pay operating expenses, though power may be offered at rates so low as to be ridiculous when compared with the cost of generating it from coal or gas. No large water power development succeeds in marketing its output except through a reduction in its selling price to a point very much below that at

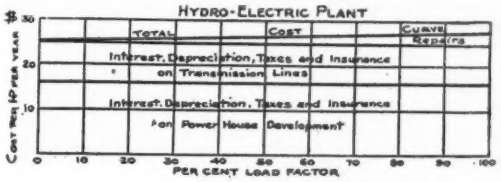

HYDRO-ELECTRIC PLANT
TOTAL COST CURVE
Interest, Depreciation, Taxes and Insurance on Transmission Lines
Interest, Depreciation, Taxes and Insurance on Power House Development
Repairs
Cost per HP per year
PER CENT LOAD FACTOR

Fig. 2.—Cost of Energy from a Hydraulic Plant.

which it could be produced from coal. Generally the load is obtained from a combination of low-priced power at the generating end with an additional load obtained by transmitting some distance to a market that will bring a higher price. At other plants the entire output is carried a long distance before a suitable market can be found. In both instances the cost of transmission lines and attendant apparatus should be added to that of the power-house development, and included in the cost of the plant as a whole; this may raise the price of power to such a point as to render it non-competitive with power produced by steam or by gas.

This is particularly true of factories having low load-factors, due to operating only 8 or 10 hours a day. In such cases, the necessary income can only be obtained through the sale of sur-

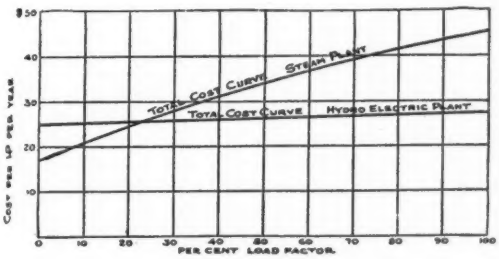


Fig. 3.—Comparison of Cost Curves.

plus power during the hours when the load is below the rated output of the power house. Similar conditions are well-known, as they have been faced by every large water-power company. It will generally be found that the most successful

plants are the ones that have the highest load-factor. The ideal load is one that remains constant throughout the 24 hours, the plant consequently putting out every kilowatt hour within its capacity. Any water-power plant loaded in this way can sell power at a price very much below its cost when produced by steam, and still leave a good margin of profit on the investment.

It is generally conceded that the only object in developing a water power is to generate electrical energy at a cost much below that of generating it in any other way, and users of power are so well educated to this fact that they will not buy hydro-electric power unless the saving effected is considerable. It must be much more in fact than that for which they would, for any other purpose, make an expenditure several times as great as that necessary to replace other prime movers.

Comparing the cost of generating hydro-electric power with that from coal or gas is somewhat difficult, but the general method to be followed is shown graphically in the curves given herewith. Figs. 1 and 2 are made respectively for both steam plants and hydro-electric plants, and show the cost of production per horse power per year with relation to load-factor. In neither of these cases is the value given from an actual installation, but is merely an approximation indicating the general conditions as they might exist in any well-built power house of a rated capacity of from 5000 to 50,000 horse power. The principal difference between the two curves is due to the introduction of the variable items of coal, water and labor in the steam plant, while the fixed charges in both cases form the base of the area included under the curve. As usual, the fixed charges include interest, depreciation, taxes and insurance. With hydro-electric plants the operating expense is so nearly constant as also to become practically a fixed charge. The item of repairs is really the only variable in the curve, this generally being considered as increasing in direct proportion to the load-factor.

By superposing the two curves, as shown in Fig. 3, it will be seen that in this assumed instance they cross each other at 25 per cent. load-factor, the cost per horse power per year being identical at this point. At load-factors less than 25 per cent., the steam plant has the advantage and hydro-electric power must be sold at a loss to be competitive. At all load-factors above 25 per cent., however, the advantage lies with the hydro-electric plant. The relative value of the two may be obtained by considering the variables—coal, water and labor—of the steam plant as the equivalent at any given load-factor, of a fixed charge, and by capitalizing this at a rate that will include interest, taxes and depreciation, and adding it to the first cost of the steam plant we can thereby obtain an approximate value of the hydro-electric development.

The conclusion is that in all places where the flow of water is constant throughout the year, the load-factor determines the earning power and hence establishes the value of any plant. Where an intermittent or insufficient supply of water may be stored and used during times of peak loads at a rate much higher than the normal flow of the stream, the earning power is not dependent on the load-factor to so great an extent, but such hydro-electric plants are generally of small capacity, adapted for lighting purposes only, and are to be considered as an exception to which the above evaluation will not apply.

Progress in Methods of Incandescent Lighting.

At the fourth annual meeting of the Association of Electric Lighting Engineers of New England, Dr. Louis Bell gave an address upon the above subject. He pointed out the need of smaller arc lighting units or their equivalent in high efficiency lamps, and then sketched the researches upon elements with high melting points in the quest of new filament material. The efficiency of a light producer depends almost entirely upon its temperature. Tantalum was found to be hard, ductile, of a higher specific resistance than platinum, and attacked only by hydrofluoric acid. It is almost infusible, had formerly been obtained only in the form of a black powder, and had to be melted in vacuo in the electric furnace before ie could be used for filament work. Dr. Bell described the tantalum lamp and exhibited one of 22 candle power to the Association in operation upon the hotel chandelier. Tests which Dr. Bell made upon a number of tantalum lamps showed an average consumption of about 2 watts per candle power, and a life of 800 hours on direct current. With a 22 candle power tantalum lamp a wattmeter revolves only two-thirds as fast as with an ordinary 16 candle power lamp. On alternating-current circuits the results are somewhat less favorable. After about 200 hours, the filament gets brittle, and tends to draw tight a little quicker than does the ordinary carbon filament. Such lamps would not be used in service where there is much vibration. They cost about $1 abroad, and at any price above 5 cents per kilowatt hour are cheaper than the ordinary incandescent, even if the latter is renewed free of charge. The filament is still not quite perfected.

Dr. Bell also exhibited as osmium lamp in operation. It had a consumption of about $1^2/_3$ watts per candle power. Osmium is so rare that these lamps are rented, abroad, and it is doubtful if they will come into very wide use in this country. It exceeds the tantalum lamp in brilliancy and is about 24 candle power in rating. There is not the same tendency to draw light as in the tantalum lamp. He then discussed the high-efficiency General Electric lamp, with a graphitized carbon filament and predicted that although the efficiency is at present from 2.5 to 2.75 watts per candle power, it is probable that within a year or two we shall have a 2 watt lamp. The life is good, on the whole, and a 20 candle power lamp is promised soon. It is a good point that the resistance of the filament is nearly uniform, being almost entirely independent of the temperature. It is hard to get long life and low candle power in a high-voltage lamp. The advent of the high-efficiency lamp means that a great many more lamps can be installed on the present systems, and if the experience of the past is any criterion it is probable that the number of new customers will more than pay for the reduction in price per lamp-hour which will follow.

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Three-wire systems of electrical distribution in which a third or neutral wire is introduced between the + and — main, are used to enable twice as many lamps to be lit with little additional expenditure of copper. To render the lamps on one side of the circuit independent of those on the other, the middle wire, which need only be thick enough to carry a current equal to the difference between the currents in the two outer wires, is carried back to the station and kept at a mean potential between the two outer wires by the use of two dynamos connected in series.

THE FUNCTIONS OF A D-SLIDE VALVE

Simple Methods of Setting this Form of Valve

Notwithstanding the fact that the D-slide valve is almost as old as the steam engine itself, there are many engineers who still have only a hazy idea of its functions. While many engines are now equipped with valves differing very materially from the D-slide valve form, yet the method of steam distribution in a cylinder can best be explained by referring to the action of a slide valve because it embodies all the functions of other valves in the shape of a simple piece of iron of the D-form.

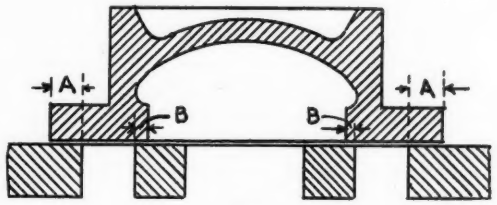

Fig. 1

There are five principal functions which a slide valve must perform in order that the engine may do efficient work: First, it must admit steam into only one end of the cylinder at the same time. Secondly, it must cover the steam ports so as not to permit the passage of live steam through both steam ports at the same time. Thirdly, it must allow the steam to escape from one end of the cylinder before it is admitted at the other end, so as to give the steam that is to be exhausted time to escape before the piston commences the return stroke. Fourthly, it must not permit live steam to enter the exhaust port direct from the steam chest. Fifthly, it must close each steam port on the steam side before it is opened on the exhaust side, so that the expansive force of steam may be utilized.

The general construction of the D-slide valve is shown in Fig. 1 and represents the valve in its central position. The two terms, steam lap and exhaust lap, can here be explained. The steam lap is that portion of the valve which overlaps the steam ports when the valve stands in its central position. This is shown at A, A, Fig. 1. The exhaust lap, or inside lap, is

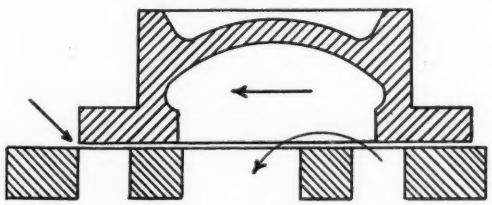

Fig. 3

that portion of the valve that overlaps the two bridges of the valve seat when the valve is in its mid-position. This is shown at B, B, Fig. 1. The purpose of steam lap is to allow the steam to be used expansively in the cylinder and the purpose of exhaust lap is to delay the release of the steam and to hasten compression. If a valve had no steam or outside lap, it would admit steam throughout the whole stroke and another effect would be a late exhaust, by which is meant that the exhaust would occur at one end of the cylinder at practically the same moment that admission occurred at the other end.

When the engine is on centre, the valve is usually moved on its valve stem, or the angle of advance is adjusted until the port just begins to open. This amount of port opening, as shown at C, Fig. 2, is called the lead and all successful engines must at least have some little lead. The object of giving a valve lead is because the steam port should be slightly opened

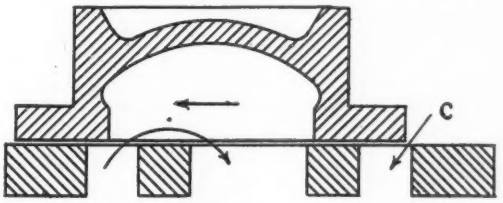

Fig. 2

for the admission of live steam just before the piston reaches the end of its stroke in order that there may be a cushion of steam to receive the piston and reverse its motion at the end of the stroke.

When the valve is cutting off, it takes the position as shown in Fig. 3. The valve is just covering the port, as shown by the arrow. Compression begins when the exhaust port is closed, before the piston reaches the end of the stroke. A small portion of the steam is thus retained in the cylinder to be compressed by the advancing piston, which thus meets with a slight cushion at the end of the stroke and all shock and jar are thus prevented. This point of compression begins when the inside or exhaust edge of valve has closed the steam port, as shown in Fig. 4, assuming the valve to be traveling in the direction indicated by the arrow.

Release occurs when the exhaust edge of the valve opens the steam port and allows the steam that has accomplished its work in the cylinder to escape into the exhaust port. This is shown in Fig. 5.

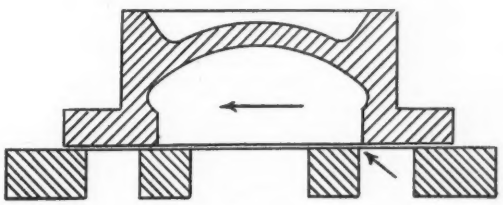

Fig. 4

The travel of the valve is the distance through which the valve moves, sometimes called its stroke. This depends upon the eccentricity of the engine. The valve should always move enough to open the port its full width and it is generally better to allow it to move further. The amount the valve travels after the steam port is wide open is called over-travel and is indicated by the distance OT in Fig. 6.

Unless the above principles of the valve are understood, trouble will always be experienced when setting a valve. It should also be understood what results are obtained by adjusting the position of the eccentric and the length of the valve stem. The position of the eccentric depends upon which way the engine is to run and whether the valve is connected directly to the eccentric or whether it receives its motion through a rocker which reverses the motion of the eccentric. When the valve is direct-connected, the eccentric will be ahead of the crank by an amount equal to 90 degrees plus a small angle called the angular advance. When a reversing rocker is used,

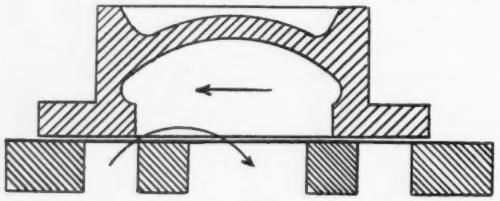

Fig. 5.

the eccentric will be diametrically opposite this position, so that it will have to be moved around 180 degrees and will follow instead of lead the crank. Shifting the eccentric ahead has the effect of making all the events of the stroke come earlier, and moving it backwards has the effect of retarding all the events, such as cut-off, release, compression and admission. Lengthening or shortening the valve stem cannot hasten or retard the action of the valve and its only value is to make the lead or cut-off, as the case may be, greater on one end than on the other. The general practice is to set the valve so that it will have equal lead.

To set the valve, put the engine on centre, remove the steam chest cover, so as to bring the valve into view, and adjust the eccentric to about the right position to make the engine turn in the direction desired. Now make the length of the valve spindle such that the valve will have the requisite amount of lead. This amount will depend upon the size and speed of

Fig. 6.

the engine, but about $^1/_{16}$ of an inch may be tried. Turn the engine over on the other centre and measure the lead at that end. If the lead does not measure the same as before, correct the difference by changing the eccentric to correct half the difference and changing the length of the valve stem to correct the other half of the difference. For instance, suppose that the lead was $^1/_4$ of an inch more on the head end than on the crank end. Lengthening the valve stem $^1/_8$ of an inch would make the valve open too soon at both the crank and head ends, and to correct this, the eccentric would have to be moved back far enough to take up the other $^1/_8$ of an inch.

When it is not convenient to turn the engine over by hand, the valve may be set for equal lead as follows: To obtain the correct length of the valve stem, loosen the eccentric and turn it into each extreme position, measuring the total amount that the valve is open to the steam ports in each case. Make the port opening equal for each end by changing the length of the valve stem. This process will make the valve stem of proper length. Now put the engine on centre and move the eccentric around until the valve has a correct lead. This will determine the angular advance of the eccentric and after fastening the eccentric in that position, the valve will be set.

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Grounding the Frames of Alternators.

There is still much dispute among central station men as to whether the iron framework of alternators should or should not be grounded. There are arguments to be made on both sides. The principal argument for grounding alternator frames is that, in the case of high-tension alternators, the attendants are liable to receive a dangerous shock from accidental contact with the frames, a condition impossible if these frames are permanently grounded. The principal argument for not grounding the frame is that such grounding increases the dielectric stress upon the insulated winding in the machine and tends to increase the risk of damage from lightning, static high-potential or internal short-circuit. The question is by no means of recent utterance. In the early days of electric arc lighting, twenty-five years ago, is was the rule to mount high-tension arc generators on wooden bases, to lay mattings of insulating material around them, and to direct the attendant in adjusting any part of the machine to keep one hand in the pocket. Now, however, pressures have increased to such a degree that the only safe procedure is to keep both hands in the pockets and keep the pockets away from the machine unless the machine framework is permanently grounded.

As a choice between protecting employees from injury, on the one hand, and protecting dynamos from injury on the other, the former is the only logical, humane and defensible selection, as soon as the voltage developed by the dynamo becomes dangerous to life. Not only is it a kinder selection to the attendants, but it is also the more economical. The increase of risk to the insulation of the dynamos is quite small if the machine is well built and the lightning arrester and static arresters are adequately installed. If, however, the machine framework is not permanently grounded and an attendant should be injured by shock in any way, either in the ordinary performance of his duty, or against rules, a jury is likely to bring a verdict of damages against the owners of the power station. The only defensible course is to save humans even if you wreck machines. Generator frames, switchboard frames, transformer frames should all and always be grounded in high-tension systems.—*Electrical World.*

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To measure the power absorbed by any part of an electrical circuit in which direct-current is flowing, it is sufficient to measure the current with an ammeter and the potential, across the part in question, with a voltmeter connected as a shunt across the circuit. The product of volts and amperes gives watts.

—o—

Whenever a horizontal steam pipe is reduced in size, there should be a drip, to avoid filling the larger pipe partially with condensed water.

The Electric Equipment of an Up-To-Date Hotel

The Application of the Electric Motor in Hotel Gotham, New York City

Many modern hotels in the larger American cities have extensive electric equipment, and the many uses to which electric power is applied in these great hostelries is certainly marvelous. The accompanying illustrations will give the reader somewhat of an idea of how extensively electric power is employed in the numerous high-grade hotels of New York, Boston, Chicago, and other large cities. The accompanying illustration, Fig. 1, shows an electric laundry equipment at the Hotel Gotham, in New York City, while Fig. 2 shows the electrically-operated vacuum-cleaning machine, and Figs. 3 and 5 the electric extractor and motor-driven mangler, while Fig. 4 gives a good idea of the arrangement of the electric centrifugal pumps for house and fire purposes.

The accompanying illustration, Fig. 6, shows the engines and direct-connected electrical generators in this handsome and elaborate hotel, which cost several million dollars. These electrical generators supply current not only for operating the various electric motors above-mentioned, as well as electric

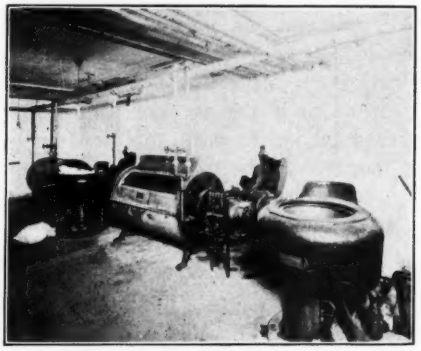

Fig. 1.—Electrical Laundry Equipment.

ventilators, fans, and other machinery, but also supply current for several thousand incandescent lamps and a number of arc lights.

There are three direct-current electrical generators of 160 kilowatts capacity each, and one dynamo of 75 kilowatts capacity, the former directly coupled to 250 horse power non-condensing engines, and the latter to 125 horse power engine of the same type, constructed at Erie, Pa., by the Ball Engine Co.

The compound-wound electrical generators were installed by the Sprague Electric Company of New York, and supply a continuous current of 250 volts pressure with an ordinary two-wire system of distribution, 225 volt lamps being utilized, as well as motors of this pressure for the kitchen apparatus, pumps, fans, and laundry electrically operated devices.

The hotel is wired in conduits, the switchboxes and fuse boxes being provided with knife switches and noark fuses.

The two fire pumps, as well as the two house pumps, shown in the illustration, Fig. 4, are of the Worthington type, operated by two 40 horse power continuous-current motors, and two 20 horse power machines directly-coupled to the centrifugal pumps. In addition to the fire and house pumps, there are two sump pumps directly-driven by motors of 3 horse power capacity.

The laundry machinery is operated by motors of 2, 3 and 5 horse power motors, the mangle requiring a 3 horse power machine, and the washing machine 2 horse power motors,

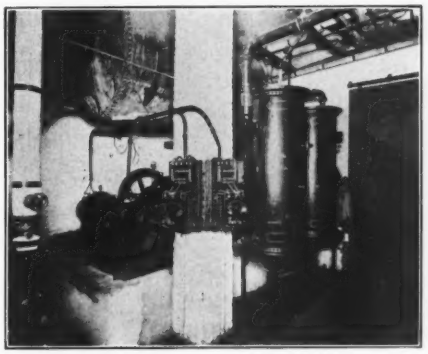

Fig. 2.—Electrical Vacuum Cleaning Machines.

while a 5 horse power motor is required for driving the main line shaft operating irons, and another motor is utilized for running the starch mixer, the drying pans, and the collar and cuff machines.

The extractor motors are three in number, and each has a capacity of three horse power, the details of operation of these machines being noted in the accompanying illustration, Fig. 3.

A large number of fans are employed in the building, ranging from 18 inches to 90 inches, of the exhaust type, in the basement, office, restaurant, laundry, and kitchen, as well as in other rooms, with motors of from ¼ horse power to 4 horse power in capacity. Cone fans are also utilized in the laundry,

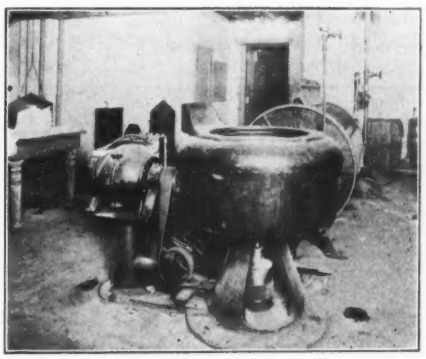

Fig. 3.—Electrical Water Extractor.

roof, store room and dumb waiter shafts varying in power required from 1 to 7 horse power, the motors being operated on the regular 225 volts circuit.

A very large number of incandescent lamps are utilized in this building operating on the 225 volt circuit, most of which are of the ordinary 16 candle power size, although for decorative features a number of 4, 6, 8 and 10 candle power lamps

have been utilized to advantage. It is stated that more than 7000 lamps have been installed and the entire electrical equipment, including the motors, arc lamps and incandescent lamps

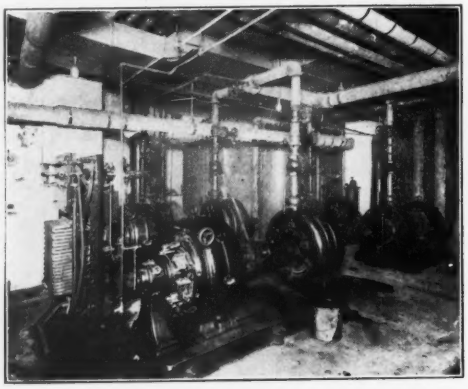

Fig. 4.—Electrical Fire and House Centrifugal Pumps.

are supplied with current from the four machines, having a total output of nearly 600 kilowatts, which is equivalent to about 12,000 16 candle power incandescent lamps.

Fig. 5.—Electrical Laundry Mangle.

The Hotel Gotham is fire-proof and is 21 stories high, electrical machinery being installed, as usual in such buildings, in the basement.

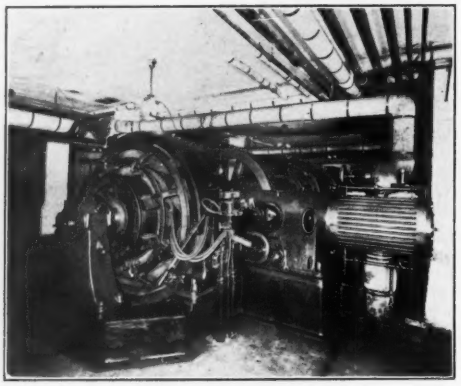

Fig. 6.—Electrical Generator Room.

The engines are supplied with steam from five Manning boilers, each having a capacity of 200 horse power, through a 12-inch high-pressure steam main connected to a 12-inch header, running the entire length of the boiler room, with 7-inch bends. The header is connected at right angles to this high-pressure steam main, which supplies the elevator pumps as well as the engine, illustrated in the accompanying view, Fig. 6.

This electrical hotel equipment is one of the most modern and up-to-date of any installation in America and gives the reader an excellent idea of the vast amount of electrical machinery and electric devices employed in a thoroughly up-to-date American hotel.

———o———

Incinerators Combined with Electricity and Water Works Plants.

"Incineration can never become a success in this country until the waste heat from a properly-constructed furnace is utilized for some useful power or heating purpose," says Mr. Joseph G. Branch, chief of the Department of Boiler Inspection and Elevators, of St. Louis, Mo., in his latest book, entitled: "Heat and Light from Municipal and other Waste." Continuing, he says: "Not to so utilize this waste heat is to lose the principal advantage of incineration over all other systems of garbage disposal and to reduce it to as primitive a method of garbage disposal as dumping and as costly as reduction.

"In a properly-constructed incinerating furnace, a temperature of 2000 degrees Fahrenheit can be constantly maintained, the gases leaving the furnace at a temperature not less than 1500 degrees, which is the average temperature maintained in a boiler furnace, and to waste this heat up the chimney is to burn up money. In the modern incinerating plant, steam boilers are installed between the incinerator and chimney, and this waste heat made to pass under them before being allowed to escape into the atmosphere, thereby not only making this heat do useful work, but removing from the gases in their long travel all dust and noxious odors before being allowed to escape. This heat is as constant as that obtained from coal-fired furnaces under boilers, and just as high a steam pressure can be maintained in the boilers. As incinerating plants are operated continuously throughout the twenty-four hours, their heavier work being at night, when garbage can be delivered with less objection than during the day, it makes their combination with electric lighting plants especially advantageous.

"The great economy of such a combination can be seen at a glance, as the waste heat which would be otherwise wasted is made to operate the electric plant without one cent additional cost. Such a combination as above described is no longer an experiment, for there are now successfully operating in England alone, over sixty such plants, while there has been recently installed in New York City, an electric plant in combination with their incinerating plant, which is furnishing lights for the new Williamsburg Bridge and the surrounding district. In Liverpool, where there are four incinerator installations located in different sections of the city, the waste heat from 300 tons of refuse is utilized for traction purposes, while in London, the resultant power from 800 tons of refuse is used for electric lighting. From this can be seen the enormous waste of power in our larger cities. In the city of St. Louis alone, it can be safely said that 3200 horse power is thus wasted daily.

"With a properly-constructed incinerator using mechanical

draft, 8 indicated horse power can be developed per ton of refuse burned, or 1200 horse power in 24 hours from a 150 ton incinerator. Allowing 92 per cent. efficiency and 11 per cent. loss, this is equal to 823.55 kilowatts or 150,889 candle power; which would permit 9430 lamps of 16 candle power each or 4716 lamps of 32 candle power each, or 336 lamps of 2000 candle power each.

"With coal at $2.00 per ton, and allowing 10 cents per ton for labor, the cost of incineration per ton of refuse should not exceed 19 cents, making a daily cost of 24 hours of a 150-ton incinerator, $28.50 or $1.19 per hour.

"Burning 6.25 tons of refuse per hour would generate 50 horse power per hour or 37.3 kilowatts, costing $1.19, or 3.2 cents per kilowatt, requiring nothing for the cost of the incineration, or $28.50 per day for the incineration, which would give the above output of electric current at not one cent cost. With three such incinerating plants in a city of six hundred thousand inhabitants, all public buildings and the principal business streets could be lighted at no expense whatever. Should the city have a term contract for its lighting with some Company, then these lights could be distributed through the parks and other public places to beautify the city.

"While it is true that the calorific value of different refuse will vary greatly, this is no serious objection, as that of coal also varies greatly. No city should be misled by statements that the garbage can be burned by itself alone. During the summer months, when the garbage will run 80 per cent. moisture, at least 90 pounds of coal to every ton of garbage must be burned; in fact, it would be safe to estimate that an average of this amount of coal per ton of refuse burned will be required throughout the entire year.

"Refuse at its best is a very poor fuel, but it has its value, and this value is sufficient to make a plant operated from its waste heat at least self-supporting, which would mean a saving of thousands of dollars to every American city, besides affording a sanitary and economical method of garbage disposal.

"What has been said as to combining electrical works with an incinerator, applies with equal advantages to such a combination with water works, especially in smaller towns. There is only one exception and that is when operated in connection with water works, a greater precaution must be taken, in order to prevent any contamination from the refuse. This can be secured by a little care and by using closing doors where the refuse is discharged."

Advertisements Read by Engineers.

By A. Edward Rhodes.

Did you ever notice how different advertisements affect different people? In Blank's engine room there is an appliance in use that has been quite a factor in the economy of the plant, and was bought only after much discussion and deliberation. It is an article that is persistently advertised in the engineering papers and by circulars sent broadcast in great quantities to all kinds and conditions of persons that might be interested in such a device, either as a purchaser or as a person likely to be able to influence prospective purchasers.

Mr. Blank had received and studied many circulars, and had read over and over again the advertisement of this article in the papers; but always had some undefined doubts about the economical working of the thing. He did not exactly know why he had this idea, but still he did not take kindly to the advertisement. One day, he called his engineer into the office and said: "Bill, do you know anything about these things; did you ever see one in use?" Now, Bill had received considerable printers' ink in the way of advertising matter from these same people, so his reply was something like the following: "I get lots of circulars about them, and see them advertised a lot and that's about all I do know about it. I have never given much thought to it; it always seemed to me it is not much good. I don't know why, but I guess the reason is something like this: This thing is an attachment intended as an additional improvement to the engine room equipment, and as shown in an old dilapidated engine room on an old out-of-date apparatus whose life should have ended years ago. The picture looks like a copy of the old woodcut engravings that were so much used when you and I were children, and somehow or other it always seemed to me that if it was any good or up-to-date it would be shown in a good up-to-date engine room, and by the modern half-tone process of illustration. Perhaps this is an unfair judgment of the apparatus, because they must be selling them somewhere or they could not afford to keep on advertising them as they do; but the advertisement seems wrong, somehow it is not convincing, it seems to speak against rather than for the object advertised, yet it also seems to say: 'I am all right, try me!'" This voiced Mr. Blank's sentiments; but as he felt the thing would be a saving for his Company, he made inquiry of several salesmen and found it was pretty generally used in certain sections of the country. He ordered one and found it to be a first-class investment.

Now the question naturally is, will all purchasers look to their interest enough to go to the trouble of investigating the merits of a disinterestingly advertised article? I think not! There are many things the advertisement pages tell and I believe most subscribers read them over, at least in a general way, and it seems to me that a good picture reproduction made from a photograph, is more convincing than words or a "made" picture. Another thing in connection with advertisements—many firms have a system of follow-up literature; that is, they get your name and address and send at regular intervals, reading matter regarding something they have for sale and which you in all probability will never have any use for. Therefore the cost of sending this literature is a dead loss. It seems to me that it would be a good plan to enclose with the first batch of circulars a "stamped" return envelope requesting a reply, stating if you are interested in the line represented. I am led to this by the fact that for several years I have been receiving advertising mail regularly from some people dealing in articles that I never have had use for and never expect to, because they are out of my line. Any of us will be courteous enough to reply when a stamped envelope or postal card is sent us, but not many of us are inclined to spend our coin for the other fellow's benefit.

Atmospheric air is a mixture composed of about 79 parts of nitrogen and 21 parts of oxygen by volume, together with a small amount of carbonic-acid gas. In 10,000 volumes of atmospheric air there are about 3 to 5 volumes of carbonic-acid gas.

Steam pipes, whether for power or for heating, should always pitch downward from the boiler, so that the condensed water may have the same direction as the steam.

The
Practical Engineer

DEVOTED TO THE ECONOMICAL GENERATION AND UTILIZATION OF POWER

PUBLISHED ON THE FIRST OF EACH MONTH BY

L. L. RICE

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The Earthquake at San Francisco.

Of all the terrors that are most appalling, an earthquake is the worst. From fire and flood and volcanic eruption man may flee, but when the solid earth trembles beneath him and the structures of stone and steel crumble and bend above him, he feels his helplessness.

San Francisco, on April 18th, was visited by an earthquake the exact results of which cannot be told. The telegraphic accounts seem to indicate that about 1000 persons lost their lives, about 200,000 people are homeless and about $200,000,000 worth of property is destroyed. The buildings that were not destroyed by the earthquake were consumed by fire which broke out among the demolished buildings, and to add to the horror, the water supply was crippled by the earthquake, and dynamite had to be used to fight the fire; at this writing the fire is still burning.

San Francisco has the profound sympathy of the rest of the country and at this writing thousands of dollars are pouring in from all sides to afford relief and to allay the suffering of its inhabitants. THE PRACTICAL ENGINEER extends its sympathy to its many engineer subscribers there.

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Increasing Scope of the Stationary Engineer.

There is no branch of engineering which has a wider scope than that of the stationary engineer and that this scope is constantly increasing is indicated by the fact that new power houses are springing up with great rapidity all over this country. One of the latest fields into which the central station has injected itself is the generation of power for steam railroads, and it is announced that the new electric system with which the New York, New Haven and Hartford Railroad proposes to pull trains between the central portion of Manhattan and points in New England will shortly go into effect, so that before another year rolls around it should be possible to judge with some degree of accuracy whether it is possible to depose the steam locomotive from the position it now holds as the propulsive power of fast passenger trains.

Twenty-five electric locomotives for the above road have been under process of construction for some time and it is reported that preliminary tests have satisfied their builders that each of them will be able to haul a two hundred and fifty ton train at the rate of more than a mile a minute, if necessary, over a reasonably smooth and straight road.

The Pennsylvania Railroad has also under consideration plans for equipping their lines in New Jersey, between Camden and Atlantic City, with electric power. This road is almost perfectly straight and practically level and the distance is about 60 miles. The distance must be traversed in one hour and the trains must be run at frequent intervals, so that it has been thought that electric power will give ideal service.

Tests upon electric locomotives seem to bear out the fact that it will not be long before many trunk lines will be equipped with electric power but achievement in actual service, however, is likely to show more conclusively what the facts of operation are than any other method of estimating results. Until the big electric motors have proved what they can do under normal running conditions, positive predictions as to their availability, of course, cannot be made.

At the same time there are many reasons for thinking that

electric power, at least for fast express trains, will be the rule rather than the exception on almost all the progressive steam roads within the next quarter of a century. From the viewpoint of the passenger and the multitudes of people living near stations on important lines, the elimination of any considerable portion of the smoke nuisance from the steam locomotives will be a marked gain.

In many cities, the smoke discharged from locomotives is a perpetual nuisance, while every traveller in summer knows how much the soot and cinders prevent the enjoyment and comfort of travel, so that the general pressure of the times seems to be toward the adoption of the noiseless, cleanly and powerful torque-producing motor for train service.

The effect of the change from locomotives to electric cars will be to replace the locomotive engineer with a man skilled in the handling of the electric motor and to dot the landscape along the lines of the railroads with electric power houses. Since each one of these power houses must have a corps of skilled engineers, the outlook for the increased demand for the stationary engineer is very encouraging.

Who in the year 1888, when the first trolley car replaced the old-fashioned tramway, would have predicted the enormous growth of the trolley car and the demand for tens of thousands of engineers which are required to handle the throttle in the power houses where the electricity is generated? All this has taken place in eighteen years, so that when the steam roads finally adopt electricity as a motive power, which they ultimately will do in some form or other, then the increased demand for the stationary engineer will be further enlarged.

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In Memory of Benjamin Franklin, Our First Electrician.

The celebration of the two hundredth anniversary of the birth of Benjamin Franklin, which was held in Philadelphia during the third week in April, was not only national in its scope but international in its significance. Men from all parts of this country and abroad assembled to do him honor as a printer, an editor, a politician, a philosopher, a diplomatist and an inventor. Born in Boston, on April 17, 1706, the greater part of his life was spent in Philadelphia, although his career was often linked with England, and ultimately with France.

While it is true that, like all men, he had his weaknesses and defects, nevertheless, it is generally conceded that the eighteenth century did not develop a man whose intellect was so varied in its resources, whose capacity for rising from obscurity to some of the highest honors of mankind was so easily exercised or whose influence upon his countrymen was so generally manifest as Benjamin Franklin and notwithstanding the fact that he became renowned among three nations, his simplicity was the admiration of the artisans, mechanics and farmers among his countrymen.

The engineering world best remembers him as the man who first drew electricity from the clouds and who first evolved the one-fluid theory of electricity, which is even held to this day. Franklin's earliest achievement in electricity was his discovery of the power of a pointed conductor to discharge an electrified body when brought near the same and to prevent the accumulation of charge upon a conductor to which it was attached. This discovery he applied later in the lightning rod. Franklin thought of electricity as a fluid penetrating all forms of matter and while totally at variance with any of the theories prevailing at that time in Europe, it naturally provoked a lively discussion but at the same time it gained many adherents who were known as Franklinists and the controversy between them lasted many long years.

After a century and a half of great scientific activity, which has added enormously to our knowledge of electricity, the ideas of electricity which are in vogue today bear a remarkable resemblance to those advocated by Franklin's one-fluid theory. The best scientists of today believe that there is one kind of electricity, namely, negative electricity, which is carried in small definite units by the electrons. These electrons are a mobile constituent of all matter and are able to move freely through metals. A negatively electrified body is one which has more than its normal complement of electrons while a positively charged body is one that has lost one or more of its component electrons. This point of view is very similar to that of Franklin's with the difference that what he thought was positive electricity is now thought to be negative.

One hundred and fifty years ago, Franklin asked: "What is electricity?" and that same question is being asked today and is no nearer a solution. There are some scientists who have been very positive that they thought they knew, but Professor Royce, of Cambridge, Mass., said, in the discussion at the celebration of the present position of the problem concerning the first principles of scientific theory, that the study of scientific theory must resolve itself into a sort of science of a thinker's ways. He said: "The modern logician has learned to see that the feeling of self-evidence which frequently attends the enunciation of a principle is commonly an indication that one has not learned to analyze the principle. In other words, self-evidence is a suspicious sign and it warns you that you do not understand the topic. If you cut a strip of paper and bring the two ends together to make a ring, it appears self-evident that any strip of paper must have two sides, and that in order to get from the inside to the outside of the ring by a movement which keeps the finger in contact with the paper, you have either to go through the paper or over the edge. All this seems self-evident until some one shows you the now well-known one-sided paper ring made of an ordinary strip of paper but so made that the two sides form but a single side."

It was once Franklin's wish that he could be brought to life a century afterwards and see the progress which the scientific world was making. In this connection it is said that he once opened a bottle of wine in which he found three flies. He took them out carefully and laid them in the sun to dry, when two of them returned to life and flew away. "Ah!" sighed Franklin, "if I could be corked up in a cask of wine and could be released and restored to life at the end of a century—what changes I would witness!"

Little did he think, however, when he was laid away that the dawn of the twentieth century would show the greatest of development along electrical lines and that the chief factor in adding to the advance of modern civilization would be the same fluid as that which he brought down from the clouds with his kite. Little wonder, then, that the most distinguished representatives of science, art and philosophy recently crowded around his grave to hail him as a benefactor of mankind.

—o—

Friction of liquids in pipes increases as the square of the velocity.

LETTERS FROM ENGINEERS

IN ORDER to make this department of THE PRACTICAL ENGINEER as interesting as possible, a moderate rate will be paid by us for all contributions published under this heading. However, we do not assume responsibility for the ideas or opinions expressed. None need hesitate to contribute because of inability to draw or write well. We will redraw or revise whenever necessary—it is the idea we want. New ways of doing old things, criticisms of accepted theories, and general engine-room experiences are especially solicited.

Banking and Cleaning Fires.

EDITOR THE PRACTICAL ENGINEER:

I notice an article on page 21 of the March issue, entitled, "Banking Fires," and written by P. J. While I have never had any experience on the water, I have been working in the capacity of engineer in such places as water works and electric light plants for over 12 years, so that I will not try to tell J. P. anything about marine engineering, but, nevertheless, I think his method of banking is the worst I have ever heard tell of.

In the first place, every engineer knows, or at least should know, what cold air does to a hot boiler plate and that it is one of the worst things that can be done. I think I am safe in saying that just so long as J. P. banks his fires in the way he speaks of, he can count on always having leaky tubes and also boiler troubles of different kinds. I have never been bothered very much with leaky tubes, not over twenty-five in all my experience and the most of them were in boilers that had been for a dozen years without ever having a tube rolled in that time.

No doubt, C. D., of Prescott, Wis., will get better results than P. J. does with the method that he uses. I have tried almost every method of cleaning and banking fires and I have never had a leaky tube since I have adopted this method, which is as follows:

Just before you are ready to shut your plant down, fire one side of the furnace and let the other side burn out; if water is low, start pump faster and try to have the water nearly where you wish to leave it by the time the engine shuts down. By this time the steam will be worked down considerably; then throw in about 14 shovels of coal on the side where you had burnt out and close all doors and just crack the damper so it will allow the gases to escape. At your arrival the next morning, you will have a lovely bank of coal. Then clean out the dead ashes and take a slash bar and throw over the live coals on the clean grates; then pull out the ashes that were left under the bank of green coal and then you have a nice clean fire without any ashes or clinkers in it.

I have a method of cleaning fires and think it is the most satisfactory way and I always instruct my firemen to do it by helping a new fireman to clean fires two or three times, so as to give him a chance to learn my method. When I am running two boilers together, I always fire two sides pretty hard, which leaves one side of each boiler to burn down to ashes. After this is done, clean out dead ashes on No. 1 boiler and then throw the fire over the grates; then throw on some more coal and let the other side burn out. Of course, No. 2 is cleaned in the same manner and so are more boilers, if more happen to be running.

It will be noticed by using these methods, as stated above, that in banking and cleaning fires, there is not much cold air admitted to the hot boiler plate through the grates. Of course, there is always a great quantity of air admitted through the fire-doors but with hand firing it is impossible to get around this point. I hope this letter will find space in your valuable paper, because I fully believe that an engineer should know how to fire aand also to be well posted on boilers before he should ever attempt to take charge of any plant.

Carey, O. M. C. R.

Thinks Fish in Suction Pipe a Joke.

EDITOR THE PRACTICAL ENGINEER:

"Can a fish live in the suction pipe of a pump?" This is certainly an odd question and reminds me of something that happened here last summer.

The village was having an artesian well drilled alongside of its electric light plant and the drillers were down about 800 feet. The village electrician (something of a wag) had occasion to turn down the commutator of the alternator; he did this without the boss of the well drilling outfit knowing of it. He put aside the turnings and when the night shift came on, told them to drop them down the well shortly before they changed shifts again. In cleaning the well, Mr. Boss finds these pieces of copper and straightway proceeds to get excited about the vein of copper down there. He wrote to the Government, asking whether copper had ever been found in limestone, and enclosed some samples that he would like to have assayed.

He got the assay all right and it certainly showed a very high per cent. of pure copper and a very high grade of mica. He also got a letter stating that copper was very rarely if ever found in limestone and that after examining the specimens that he had sent, the assayer had come to the conclusion that the hole had been "salted," or, in other words, the copper had been dropped down the well. I think that Mr. O. G., if he will quietly investigate, will find that some friend of his took an odd way of presenting him with a fish dinner, unless it happened to be a dog fish or a gar fish.

Dolton, Ill. E. C. K.

Why Do the Valves Stick?

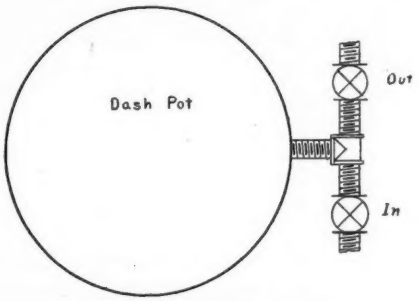
EDITOR THE PRACTICAL ENGINEER:

I have been much interested in the answers given to the above question in the April issue of THE PRACTICAL ENGINEER. Mr. H. H. H. tells us to advance the eccentric and give the valves more lap. This is a good remedy under some circumstances but one that cannot be applied under all conditions.

The best remedy I have found for that difficulty is one that can be easily applied by any engineer with very little expense or trouble and I have always found it effective with me. Take two ¼-inch lock valves for each dash pot; file off the collar on the end of the valve stem which is used to hold the disc in place, allowing the disc to move freely on the valve stem. Ordinary check valves can be used if desired, but the lock valve can more easily be adjusted when in use.

Then remove the air pet cock which is always screwed into

the side of the dash-pot. Put a short nipple in its place, then put on a tee, and with two more nipples put on the two valves, as shown in sketch. One of the valves should have the check opening in, and the other valve, the check opening out. By adjusting the valves properly, the piston of the dash-pot can be made to close with a bang or just close quietly, as desired.



Remedy for Sticky Valves

I have taken old, worn-out dash-pots, which have caused an almost endless amount of trouble, and by applying the valves in this way, I have made them into respectable pieces of machinery which do their duty faithfully and well. The expense is almost nothing, and applied to any vacuum dash-pot, improves the working of it and removes one of the sources of anxiety and trouble for the engineer.

If ordinary check valves are used instead of the lock valves, it will be necessary to put an adjusting screw in the cap of each valve. This can be done by drilling and tapping for a machine screw and then using a wrench or screw-driver when adjusting.

Methuen, Mass. S. J. S.

Lengthening Rocker Arms will Cure Sticky Valves.

EDITOR THE PRACTICAL ENGINEER:

The reason why I think N. L.'s engine valves stick is because release is too early and the exhaust valves close too early, which makes back pressure too great. If the valve would drop at that time with so much back pressure it would be a case of cylinder head blown out. Let him lengthen the lower rocker arms about one turn or more, if necessary. This, I think, will cure the trouble.

St. Paul, Minn. H. Z.

Care Should be taken when Heating Castings.

EDITOR THE PRACTICAL ENGINEER:

Referring to the "Peculiar Explosion of a Solid Piston," described by A. D., in your March issue, I would mention that I read in the *Scientific American,* about twenty-five years ago, of a similar occurrence and with fatal results to the man heating the piston. The explanation given at the time was that there was water imprisoned in flaws or other spaces in the casting which had been confined by the closing of the hole or holes through which it entered and which would be particularly favored if the outlet of the flaw were on top so that water entering could not escape. There does not appear to be any other explanation to offer except the generation of steam from such imprisoned water of sufficient pressure to cause destruction of the article being heated.

So profound an impression did this make upon me that on many occasions when heating large cast-iron pipe fittings preparatory to separating, I have religiously refrained, after starting such heat, to approach the object until the maximum heat had been passed, which is the safe side in all cases when heating other than a piece of *known solidity.* This procedure with heating fittings has been a source of trouble, it is true, but it is worth a thousand times such trouble to prevent an occurrence of this kind, and in all my pipe fitting heating there has not been a single explosion.

In 1895, a personal friend of mine, an estimable and accomplished engineer, was killed in New Orelans in same manner, the pump rod with a portion of the piston penetrating his body. Therefore, I do not feel as if I can afford to heat any unusual piece without the greatest precaution.

New Orleans, La. J. O. FRAZIER.

Piston Explosion Caused by Water.

EDITOR THE PRACTICAL ENGINEER:

In nswer to A. D., of St. Joseph, Mo., as to what caused the piston to explode, I would say that it was a steam explosion and happened this way:

The piston, being cast solid or in one piece, had a cavity or sand hole in it with a narrow channel leading to the outer edge which if it could be seen at all, would not give any thought of trouble or of being imperfect. This would, however, allow water to get into the sand hole in time and then the crack may have become sealed with sediment and rust, which would hold the water for an indefinite length of time, so that when placed in the fire nothing could prevent an explosion.

Some may think it must have been a pretty big cavity to cause such a strong explosion, but if any one has any doubt as to how much force there is in even a small amount of water when confined, let him drill a hole in a casting and put some water in; then plug it tight and build a fire out-doors away from everything and place the casting in it. I have tried this and know just about what to look for!

Rose Hill, N. Y. M. E. WEBBER.

Parts of Engines that have come into Contact with Oil Should be Thoroughly Examined before Heating.

EDITOR THE PRACTICAL ENGINEER:

In the March number, A. D. describes a peculiar explosion of a solid piston and asks for the cause. In the first place, a casting that has been used in a steam cylinder for any length of time or that has come from any machine that has come into contact with oil should not be put into the fire until thoroughly examined for blow holes, which may allow the oil or water to lie in them, for as soon as heated the oil will be converted into gas and cause an explosion.

I have had two cases of this kind, the last being similar to his, only that no one was hurt. After putting the piston in the forge, I left it for a minute to get something to knock the rod out, and while I was gone, it burst, breaking into four pieces. On examining it, a small blow hole ⅛-inch in diameter, that opened into a ¾-inch opening, was found on the back face about 1 inch from the end of the rod. As I was in a hurry and as it was covered with scale, I did not notice it, for

it must have been filled with oil and water and the scale kept the air out and the explosion followed.

In the other case, a hollow piston capped at the ends and being used on an oil pump, required a new rod. To get the caps off, which were rusted, I held the piston by the rod over the fire and not more than one minute elapsed before the cap on the farther end blew off, letting out some oil that had been enclosed in the hollow part. As no blow holes could be found, it was thought that the oil worked in between the rod and cap some time before, so I think that in A. D.'s case, the piston contained oil or water.

East Boston, Mass. D. F. C.

Remedy for Hot Step Bearing.

EDITOR THE PRACTICAL ENGINEER:

The following may be of interest and perhaps a help to some of your readers. About ten years ago, I took charge of the plant that I am now running; it was a new one, having just been completed. Among other appliances which at that time were up-to-date was a vertical shaft 4⅞ inches in diameter at the bottom and reducing to 2⅞ inches at the top and 112 feet high, weighing, including pulleys, about 4 tons.

The entire weight was supported on discs at the bottom, as shown in Fig. 1, the bronze end of the shaft being smooth and running on a case-hardened steel disc with cross oil ways and hollow centre, as shown in Fig. 2. This steel disc rested in turn on a bronze disc of the same design as Fig. 2 and this lower bronze disc rested upon a hexagon case-hardened steel disc, the under side of which was slightly pointed and rested in a slight indentation in the bottom of the step case or oil box. The oil box was filled to the top with oil, the discs being all submerged, as shown in Fig. 1.

Almost from the start this bearing gave trouble, sometimes getting so hot as to boil the oil and even setting fire to it. Several times the makers were called in to help us out, but

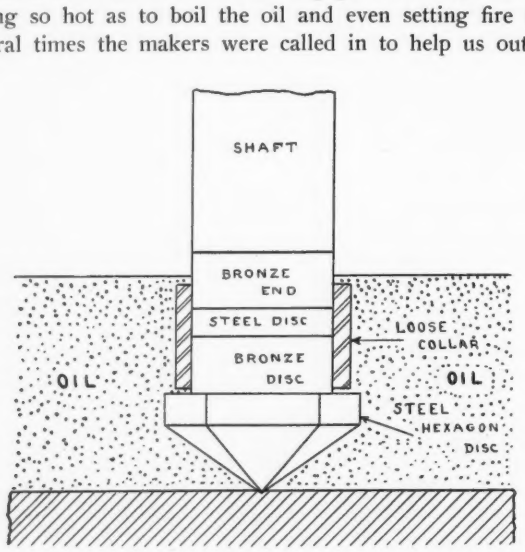


Fig. 1

they could not do any more than we could and the only encouragement they gave us was to say that all bearings of that kind did the same. This did not help us out, however, so feeling that it was up to me to do the trick, I reasoned it out and hit upon the idea of a circulating disc, as shown in Fig. 3.

I had noticed that when the shaft revolved, which it did at the rate of 320 revolutions per minute, the discs had a tendency to throw the oil away from themselves. I therefore had a bronze disc cast and turned it up to the same size as the others and faced it off; then bored a ¾-inch hole in the centre to correspond with hole in the steel disc and turned the oil chan-

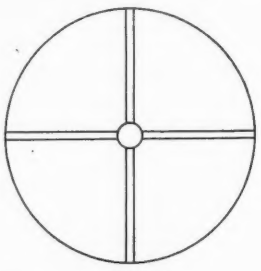


Fig. 2

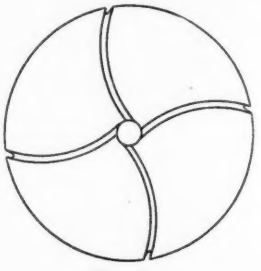


Fig. 3

nels as shown; then cut pockets in the edges of disc so as to act as scoops, thus having a tendency to scoop the oil in, which was being carried away by centrifugal force. With the new arrangement, the oil was forced to the centre hole and out through the straight oil ways in the steel disc; this I found to work admirably and it has been running for nearly seven years and has given absolutely no trouble. I have also helped others out of the same trouble in the same manner. The bronze disc as shown in Fig. 3, you will understand, takes the place of the original bronze with the cross oil ways.

Brooklyn, N. Y. L. F. J.

Are These Fair Examination Questions?

EDITOR THE PRACTICAL ENGINEER:

I enclose a set of questions which were given to an engineer applying for a first-class license here, as I think some of your readers might like to see them. I gave them to the N. A. S. E. boys here, but none of them who already had first-class license papers seemed to be able to answer them. The questions follow: Considering an upright high-speed cross-compound condensing 2000 horse power engine,

(1) Give economical boiler pressure.

(2) Give approximate initial, terminal and mean effective pressure of each cylinder.

(3) Give approximate dimensions of each cylinder.

(4) Give approximate speed.

(5) Draw approximate theoretical cards of each cylinder.

(6) Draw approximate cards of each cylinder with proper compression but admission ¼th of the stroke later.

It seems to me that such questions are a direct violation of the law for Section 3, of the Act of 1899, which says that the applicant shall be given a practical examination, and if such questions constitute a practical examination, then the dictionary meaning of the word practical must be a mistake, for I think they are more theoretical than practical.

Fall River, Mass. J. R.

The Value of the Damper Regulator.

EDITOR THE PRACTICAL ENGINEER:

Thinking that a few of my experiences may be of interest to your readers, I send the first one along.

I was called to look over a steam plant, a few years ago, in which there seemed to be a lot of trouble. One of their

troubles seemed to be that they were burning a lot of coal and were not able to get the steam they needed to do the work. While we were looking for the trouble, we noticed that the fireman, after firing, would sit down for a few minutes and then get up and open his fire-doors and after awhile put more coal on, shut his doors, then open them again and let them remain open until the steam had run down, and then he would shut them again.

After going over the plant and deciding that it was the method of firing that caused the trouble, we talked with the fireman about opening his fire-doors and leaving them open. He said in reply that if he did not open the fire-doors, the steam would run up too high. We then suggested to him to shut the damper, but he said that he did not think there was any damper in the chimney, as he had never heard of there being one. After careful examination, we found that the plant did not contain a damper anywhere. We let the fireman go on for a few days until we could arrange to get a damper made and procure a damper regulator, during this time carefully noting the amount of coal used.

After fitting up the damper and a damper regulator, we found the boilers could very easily do the work and have a lot of steam ready for any emergency. We also found that we were making a saving of coal which amounted to about 20 per cent. over the old plan.

Watertown, Mass. H. M.

Belts and their Arrangement.

EDITOR THE PRACTICAL ENGINEER:

In your January issue, W. A. Dow makes some very pertinent remarks concerning the use of belting. However, the placing of an idler midway between two pulleys, on the slack side, does not seem to be the best solution of the problem of increasing the arc of contact on the driving pulley. Instead of using the arrangement shown in his Fig. 2, it would seem better to place the tightener near the driving pulley, as shown herewith in Fig. 1. In any case, the arrangement of a horizontal belt in such a manner that the driving side is uppermost, is one to be avoided if possible. A far better way is to make the lower side the driving side, as shown in Fig. 2, since the slackness of the upper side then increases the arc of contact without the necessity of tighteners. A tightening pulley is liable to be a source of considerable trouble. For, if it is set up too hard, it throws increased stress upon the belt and increases the pressures upon the shaft bearings, resulting in shorter life of both belt and bearings, with, perhaps, trouble due to overheating of the latter.

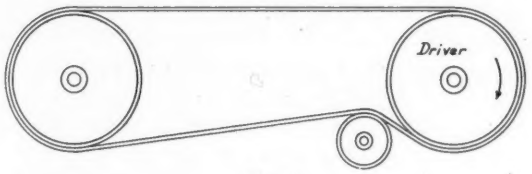


Fig. 1

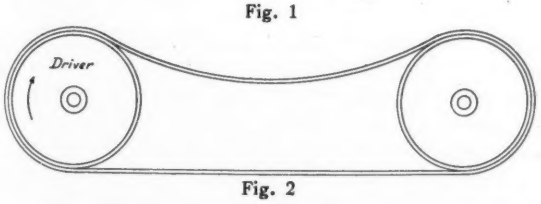


Fig. 2

In arranging belts to connect pulleys lying in different planes, whether by the use of idlers or by the familiar quarter-turn,

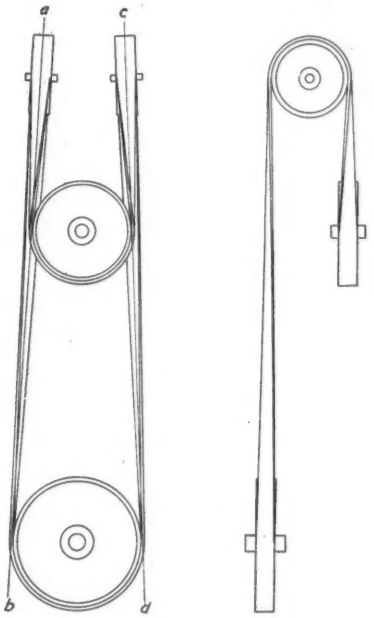


Fig. 3

the rule to be borne in mind is that the point at which the belt leaves one pulley must lie in the middle plane of the next succeeding pulley. In this respect, the arrangement given in the last illustration in Mr. Dow's article is faulty, and the belt will not run in either direction. The correct arrangement is clearly shown in Fig. 3. Here it will be observed that the middle planes of the guide pulleys, represented by the lines *ab* and *cd*, are tangent to both the main pulleys, and as a consequence the pulleys may rotate in either direction.

Again, in his fifth figure, Mr. Dow shows both sides of the belt as being in service, the belt being given a half twist, so that at the point of lacing, the flesh side and the hair side are together. This may be the fault of the illustrator, but it should be noted, anyhow. The arrangement herewith shown in Fig. 4 is preferable, since the same side of the belt touches the main pulleys and the guide pulleys. In case both sides are used, the belt is bent over the pulleys first in one direction and then in the other, which action must shorten the life of the belt, especially if the bends are of small radius.

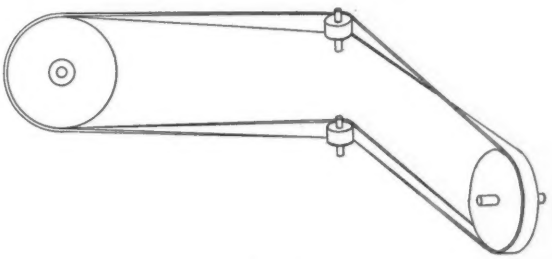


Fig. 4

In case guide pulleys are so placed that their axes are ver-

tical, or nearly so, as in Fig. 4, it is necessary to provide flanges on the lower edges to prevent the belt from running off, due to the sagging under its own weight. In most cases, the guide pulley is made as in Fig. 5, which shows a sectional view. That is, a square flange is merely added to an ordinary guide pulley. If the belt has considerable length, its sagging is liable to cause the edge to crush and curl, as shown at *a*, which will stretch the lower edge of the belt and wear it out

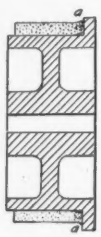


Fig. 5

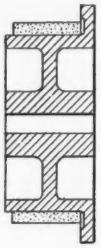


Fig. 6

rapidly. To prevent this action to a great extent, the guide pulley may be made as shown by the section in Fig. 6. In this, the flange is under-cut, so that after it has guided the belt to the pulley surface, there is no angle in which the edge of the belt can be caught and crushed.

In the care and management of belts, the use of belt dressings is not to be despised. A preparation which will keep a belt soft and pliable, and will not injure the fibre, is to be recommended, and will be found to lengthen the life and improve the service of a belt. Castor oil and neat's-foot oil have both been used to a large extent as belt dressings, and have been found excellent. The use of any resinous or tarry compound, however, is to be condemned. For, while it will cause the belt, for a short time, to adhere closely to the pulley face, it will soon harden and dry, after which it will lose its adhesive properties. This is then followed by cracking, and the cracking is quickly communicated to the belt also.

Scranton, Pa. R. T. STROHM.

Operation of Three-Wire Generators.

EDITOR THE PRACTICAL ENGINEER:

Replying to R. H., Minneapolis, Minn., regarding the operation of the three-wire generator, will say that I have operated two such machines of the Westinghouse make and am intimately acquainted with the operation of others in this city and have never found or heard of any special trouble other than that experienced with the ordinary two-wire generator.

In construction, as given by the Editor's reply to his inquiry in March number, the armature is practically that of a two-phase rotary converter, though the parts are proportioned differently. The commutator brushes deliver their current directly to the two outer wires of the circuit, while each phase of the alternating current from the collector rings is connected to a balance coil, the mid-points of which are connected and the middle, or + and — wire, tapped from there. Besides this three-wire arrangement of the armature, the machine will be found to differ from the ordinary two-wire generator in that the connections of the series or compound field winding are modified slightly. Instead of connecting all coils in series, the alternate poles are in series, that is, all north poles are in series with one side of the line and all south poles with the other side. This allows the compound winding to compensate for any drop in either side independently, and irrespective of load on the other side of the circuit, giving a close regulation even with unbalanced loads. The shunt field coils are connected as in ordinary machines.

Ordinarily the balance coils are furnished of sufficient capacity to handle a load of 25 per cent. unbalance, but I have known them to operate 100 per cent. out of balance sparklessly and without undue heat of the coils.

Their advantage over a two-wire generator and a motor balancing set is that they depend upon no auxiliary apparatus, as a failure of the balancing set may cause a great deal of trouble on the line. There should be no trouble with the balancing coils, especially if the circuit is balanced or nearly so, as in that case but little or no current will flow in the coils or the + and — wire. The commutation does not differ from the two-wire machines. They are paralleled as any direct-current machines would be, but use an extra equalizing switch, as a two machine set operating on Edison system does, giving the two sides of the circuit a chance to equalize independently. With the three-wire machine of a capacity to handle the unbalance, two-wire machines may be paralleled with it, or a machine of half the voltage may be run in multiple with either side of the circuit, or two machine sets (Edison system) may be run in parallel with it, giving considerable flexibility of operation when a variety of machines are available.

An ammeter should be used in each side of the circuit, though but one voltmeter is necessary if a voltmeter switch is provided.

Washington, D. C. W. E. L.

Recipes for Cleaning Brass.

EDITOR THE PRACTICAL ENGINEER:

The following is a recipe for cleaning all kinds of hot brass cylinder heads and jackets. I have been using it and I find it works fine and it is something I think every engineer will at some time use.

Take coal ashes sifted out fine and mix with kerosene oil to a thick paste; then add air-slacked lime, as much as can be conveniently mixed with it. Apply the polish to the bright parts, rubbing hard; then wipe off and rub with dry slack lime.

Another recipe that I found useful for cleaning brass is as follows: Take whiting and ammonia and mix to a paste; then apply and rub dry. This works very well and does not cost much.

Exeter, Canada. N. L.

Model Engineers Organize.

The American Society of Model Engineers held their first meeting at the Gilsey House, New York, on April 18th. The following officers were elected: President, Mr. F. W. Geissenhainer; Vice-President, Mr. E. B. Frank; Secretary and Treasurer, Mr. W. E. Spon, 123 Liberty Street, N. Y. A considerable amount of work was successfully accomplished and it was decided to hold the next meeting early in May.

QUESTIONS and ANSWERS

THE editor will be glad to receive from the readers of THE PRACTICAL ENGINEER, such questions relating to engineering subjects, as may, from time to time, occur to them. All questions and answers should be addressed to the editor and accompanied by the name and address of the writer, which will not be published, however, unless especially desired. It is the intention that questions shall be answered by the readers, and even though the editor may, from time to time, publish answers and questions, he especially desires the readers in such cases to contribute any further information, in connection with the points raised, that they may consider of interest. All questions and answers received by the editor will be published, as far as practicable, but he reserves the right of editing or rejecting any communication.

Efficiency of Motor. Current Flowing in Divided Currents.

EDITOR THE PRACTICAL ENGINEER:

Will you please answer the following questions?

(1). A shunt wound motor requires a current of 0.9 amperes at 500 volts when running free. The field resistance is 657 Ohms and the armature resistance is 2.5 Ohms. When the motor is taking 12.5 amperes at 500 volts, what is the output in watts and the efficiency and what is the field loss?

(2). Three branches of a circuit have resistances of 18, 24 and 30 Ohms, respectively. The fall of potential between the points where the branches divide and where they unite is 108 volts. What is the joint resistance of the branches and how much current is flowing in each branch?

Everett, Wash. B. F.

(1). The efficiency of a motor can be found in two ways: one which is purely electrical and one which is a combination of mechanical and electrical methods. The latter is by far the more preferable, but in the above case, the electrical method of calculation must be resorted to. The resistance of the field coils and that of the armature being known, the losses in those two parts can be determined separately. The resistance of the field coil is 657 Ohms; since the voltage supplied to the motor is 500 volts, the current flowing through the field is obtained by dividing the 500 by 657, which gives .761 amperes. Multiplying this current by the voltage, the energy absorbed in the field coils is obtained, or $500 \times .761 = 380.5$ watts.

The armature current increases with the load so that the loss due to the resistance of the armature coils is small, when the machine is running free, and will increase as the load increases. In the given case, the resistance of the armature is 2.5 Ohms and the current flowing through it 12.5 amperes, so that the voltage absorbed by the armature is equal to $12.5 \times 2.5 = 31.25$ volts. Multiplying this voltage by the current, the loss due to armature resistance when running under the given load is obtained, or $31.25 \times 12.5 = 390.6$ watts.

It was found that with the motor running free, the motor required $500 \times 0.9 = 450$ watts to make it turn. Of this amount, 380.5 watts is used up in the fields, $0.9 \times 2.5 \times 0.9 = 20.25$ watts is used up in heating the armature at no load, leaving $450 - (380.5 + 20.25) = 49.25$ watts for mechanical friction and hysteresis loss, which are practically constant in a given motor running at the same speed.

The losses then when running at 12.5 amperes are $380.5 + 390.6 + 49.25 = 820.35$ watts. The total number of watts input are then $12.5 \times 500 = 6250$ watts and the number of watts available for useful work are $6250 - 820.35 = 5429.65$ watts. The efficiency is then obtained by dividing 5429.65 by 6250, which gives 86.8 per cent. efficiency.

(2). The joint resistance of three circuits in parallel is obtained by multiplying the resistance of the three circuits together and dividing that product by the sum of the product of each of the resistances multiplied by the other two. In the given problem the joint resistance is obtained as follows:

$$\frac{18 \times 24 \times 30}{18 \times 24 + 18 \times 30 + 24 \times 30} = 7.65 \text{ Ohms},$$

which is the resistance of the three branches in parallel.

According to Ohm's law, the current flowing in each circuit is obtained by dividing the drop in potential by the resistance. In the case of circuit containing 18 Ohms, the current is equal to $108 \div 18 = 6$ amperes; in the case of the circuit containing 24 Ohms, the current flowing in that circuit is $108 \div 24 = 4.5$ amperes; and in the case of the 30 Ohm circuit, $108 \div 30 = 3.6$ amperes will be flowing through it.—[Ed.]

Thickness of Boiler Shell. Time and Coal Required to Empty Tanks.

EDITOR THE PRACTICAL ENGINEER:

I would like you to help me out with a few questions, which are as follows:

(1). If the tensile strength of steel is 60,000 pounds per square inch, what thickness must the shell of a cylindrical boiler be to stand a pressure of 100 pounds per square inch, the boiler being 48 inches in diameter, factor of safety 6?

(2). We are putting in a pair of compound engines and are using a boiler pressure of 120 pounds. Our low-pressure cylinder is 48 x 32 inches. What size cylinder would you have for your high-pressure?

(3). We have a tank full of water in the morning when we commence work. If the tank is 8 feet in diameter and 12 feet deep, how long will it take to empty the tank, if we are using 1300 horse power?

(4). We have a circular tank full of water. It is 12 feet in diameter at the top, 15 feet at the bottom and 15 feet deep. How much coal will it take to evaporate the water into steam, if the temperature of the water is 100 degrees?

Bellville, Ill. H. M. W.

(1). Eliminating the question of riveting, a cylindrical boiler is twice as strong transversely as longitudinally. The formula for finding the thickness of a boiler to resist bursting in a longitudinal manner is

$$T = \frac{PD}{2c}$$

in which T is the thickness of the plate in inches, D is the diameter in inches, c is the allowable tensile strength and P is the boiler pressure in pounds per square inch. Substituting the given valves, the formula becomes:

$$T = \frac{100 \times 48}{2 \times 10{,}000} = .24$$

or about ¼ of an inch. In practice, however, the shell would be made somewhat thicker to allow for the percentage of strength of the riveted joint.

(2). Conforming with general practice, the high-pressure

cylinder should be made about 24 inches in diameter.

(3). A tank 8 feet in diameter and 12 feet high contains 603.18 cubic feet or 37,698 pounds of water. If the boilers are using 30 pounds of water per horse power per hour, 1300 horse power would be equivalent to the use of 39,000 pounds of water per hour, so that it would take the tank about 58 minutes to be emptied.

(4). A tank of the given dimensions has a capacity of 2155.5 cubic feet and will contain 134,718 pounds of water, taking a cubic foot as equivalent to 62.5 pounds. Assuming the steam to be generated at atmospheric pressure, it will require 1078.6 heat units to raise one pound of water from 100 degrees to steam. Assuming also that average coal contains 13,000 heat units and that 70 per cent. of its heat is given to the water, then 9100 heat units are available for evaporation per pound of coal; or, one pound of coal will evaporate 8.44 pounds of water under the given condition. Dividing 134,718 by 8.44 will give the number of pounds of coal required, which figures out 15,962 pounds.—[Ed.]

Putting an Engine on Centre.

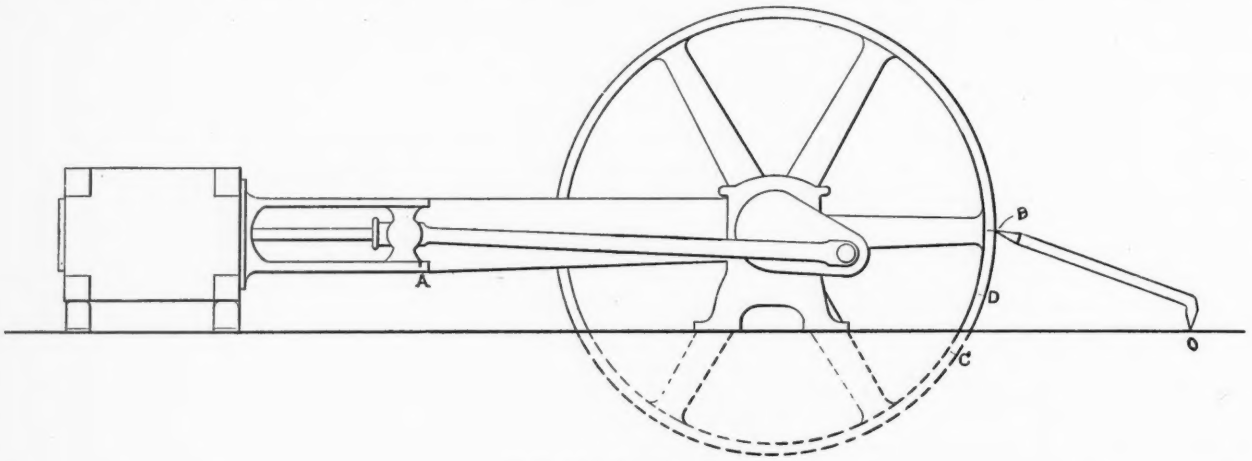
EDITOR THE PRACTICAL ENGINEER:

Will you please give directions, through your magazine, for putting a horizontal engine on dead centre?

Waltham, Mass. R. W. G.

As there are two centres of an engine, it is necessary to proceed separately in each case, but the method of procedure is exactly the same. Suppose the crank is to be put on the outward centre; then turn the fly-wheel so that the crank makes an angle of about 15 degrees with the centre line of the engine. This angle can be anything that the operator desires, but it should be great enough to give plenty of sweep to the crosshead and still not have too great an arc on the fly-wheel. Having decided upon the angle, make a mark on the crosshead guide, as shown in the accompanying sketch at A, to correspond to some mark on the crosshead. Usually the best plan is to scribe a very fine line on both crosshead and guide. Then, selecting some fixed point on the ground or engine frame, as at O, describe a line on the fly-wheel, as at B, with a tram of convenient length. This tram is shown at OB.

The fly-wheel should now be turned until the crank passes the centre and the crosshead travels back until the line on the crosshead exactly again coincides with the mark on the guide at A. When this point is reached, the fly-wheel is stopped and a second line is scribed on the fly-wheel, as at C, the line C being where B is shown in sketch. The distance between B and C on the fly-wheel should be carefully bisected and the line D drawn. When this centre line D has been drawn, the fly-wheel should be turned so that the point of the tram will exactly come to the line D. The crank should then be exactly on dead centre. In turning the fly-wheel, should it happen that the wheel is turned so that the mark D falls beyond the point of the tram, the fly-wheel should be reversed not only enough in direction to bring the mark D opposite the point of the tram, but it should be carried over the distance and then brought up to the point again in its original direction. This will obviate any error due to lost motion in the bearings. The same procedure is followed to place the crank on the dead centre at the opposite end of the stroke.—[Ed.]



Method for Centering Engine

Compressed Air as an Agent for Refrigeration.

EDITOR THE PRACTICAL ENGINEER:

Please give in your next issue some information concerning the use of compressed air as an agent for refrigeration.

Wilson, N. Y. E. A. S.

Machines constructed on this system operate on a principle which is one of the simplest in physics; that is, that the compression of air or other gas generates heat and the subsequent expansion thereof cold. One of the first machines of this class is said to have been designed by Gorrie, in 1849, but the imperfect cooling of the air after compression, combined with the damp condition of said air, caused the failure of the machine to act in a satisfactory manner. In 1863, Dr. Kirk invented a machine which had three cylinders, one for compressing the air and two for the expansion thereof, all three of which had reciprocating motion imparted to their pistons by a single crank. One of the expansion cylinders was connected to each end of the compressor, thus actually forming two distinct systems. The pistons of the expansion cylinders were hollow and were perforated by a number of small holes, and fitted internally with filters consisting of several layers of very fine wire gauze, the reciprocating action of the said

pistons alternately causing air to pass through these perforations and filters and drawing back said air. In this machine, the cold air was caused to abstract heat from brine which circulated around the top cover of the expansion cylinder and through a number of hollow corrugations.

In 1869, a cold air machine adapted to compress air in stages was invented by Marchant. In this apparatus, the air was passed first into one cylinder wherein it was compressed and was then exhausted into another cylinder of smaller dimensions, in which it was still further compressed. In 1873, a decided advance in the cold air machine was made by Windhausen, the characteristic feature of which was the improved method by which the air, that had become heated by compression, was first cooled in a series of condensers or coolers by means of a circulation of cold water. In 1877, the improvements introduced by Bell and Coleman added very considerably to their practical value. These improvements comprised suitable means for cooling the air both in and as it left the compressor, by spray or jets of water and also for drying it again before it passed into the expansion cylinder. The latter object was effected by causing it to flow through a set of coils or pipes situated in the chamber cooled by the machine or by providing for exposing these pipes to a current of air passing from the chamber. A great objection to this system of cooling was the loss occasioned by the saturated condition in which the air, even when employed continuously over and over again, is constantly delivered to the machine. In 1880, Lightfoot introduced an improved machine, wherein the expansion is performed in two stages. The advantage of this arrangement is that during the first stage of expansion, the air can be made to deposit most of its moisture, after which the dry air is further expanded until it attains the required temperature and pressure. From that time on, numerous machines have been designed as described above with various improvements so as to increase the efficiency of the system.

The main objections to all cold air machines are as follows: The cold air, as a rule, is employed direct, in which case the temperature of the refrigerator rises immediately in case any stoppage of the machine has to be made for repairs or other purposes, by reason of there being no cold that can be utilized. They are very costly to maintain and manage, entailing a large outlay for fuel and lubrication and they also require large quantities of condensing and circulation water. The principal advantages of the cold air system are: No chemicals of any description are required, consequently their employment is not attended by any danger from explosion or accidental escape of deadly gases. Very low temperatures can be rapidly obtained by their use. The construction of the apparatus is simple and its application easy. The entire machine is situated externally to the room being refrigerated and all parts are therefore accessible at all times.

A matter of the greatest importance, where air is used as a refrigerant, is to ascertain to what degree any water that may be present may affect the heating or cooling of the air, besides the formation of snow and ice, which is a very objectionable feature. Moisture in the air occasions loss of efficiency in two ways. If the air enters the expansion chamber in a saturated condition, when the air is cooled by expansion while performing work, a certain amount of vapor is condensed and thrown down; the point of saturation being dependent upon the temperature. The vapor in thus changing to the liquid state, gives its latent heat of vaporization to the air; and as the expansion of the air continues, and the temperature is still further diminished, the liquid freezes and accumulates in the form of snow and ice in the valves and passages, giving up its heat of liquefaction to the air. Thus, not only does the presence of moisture in the air produce mechanical difficulties, choking the air passages and impeding the action of the valves, but for the same expenditure of energy, the cold air leaves the machine at a higher temperature than would have been the case if there had not been a surplus of moisture in the air during expansion.

Much can be said, however, in favor of cold-air machines, when the cost of fuel is not of vital importance and they possess certain qualities that render them especially advantageous for marine installations. For breweries, chemical works, paraffin and other works, those machines operating to produce cold by evaporation of a volatile liquid, especially ammonia machines, will be much better. When a cold-air machine is employed for refrigeration, the cold air is, as a rule, admitted to the cold chamber through ducts placed near the ceiling and after it has performed its function, it is conducted back again to the compressor, wherein, after being mixed with a sufficient amount of fresh air, it is again compressed.—[Ed.]

Volume of Steam Space and Number of Gallons of Water in Boiler.

EDITOR THE PRACTICAL ENGINEER:

Please answer the following questions through the columns of THE PRACTICAL ENGINEER. I had these questions put to me at an examination for Hoisting Engineer, and I failed on them:

The dimensions of a return tubular boiler are as follows: Diameter, 60 inches; length between heads, 16 feet; outside diameter of tubes, 3½ inches; number of tubes, 64; distance from mean water line from top of boiler, 18 inches.

(a) Compute the steam space of the boiler in cubic feet.

(b) Determine the number of gallons of water that will be required to fill the boiler up to the mean water level.

Shelburn, Ind. H. W.

(a) The practical man should not be compelled to answer this question without the use of a table of segments. To use the table, divide the height of the segment by the diameter of the boiler; find the quotient in the table opposite to which is the corresponding area for a circle whose diameter is one; square the diameter of the boiler and multiply it by the area found as above; the product will be the area of the segment. For instance, in the given problem, the diameter is 60 inches and the height of the segment is 18 inches and the length of the boiler is 16 feet. Dividing 18 by 60, gives 0.3 as the quotient and it is found in the table that the area corresponding to this ratio is 0.1982. Squaring the diameter and multiplying it by the area for unit circle, gives $60 \times 60 \times 0.1982 = 713.52$ square inches as the area of the steam space. Multiplying this area by the length in inches will give the cubical contents, or $713.52 \times 192 = 136{,}995.84$ cubic inches or 79.3 cubic feet, the steam space of the boiler required.

(b) The area of end of the boiler is 2827.43 square inches. As found above, the area of the segment above the water level is 713.52 square inches, so that $2827.43 - 713.52 = 2113.91$ square inches, the area below the water level. Now the water

fills all this space except for the tubes, the area of which must be subtracted from the latter figure. The area of a 3½-inch tube is 9.6211 square inches, and as there are 64 of them, their combined area is 615.75 square inches. Then, 2113.91 — 615.75 gives 1498.16 square inches as the area occupied by the water. Multiplying this quantity by the length in inches will give the volume of the water in cubic inches, or, 1498.16 × 192 = 287,646.72 cubic inches. Since there are 231 cubic inches in a gallon, this is equivalent to 287,646.72 ÷ 231 = 1245.2 gallons, which is the number of gallons required to fill the boiler up to the mean water level.—[Ed.]

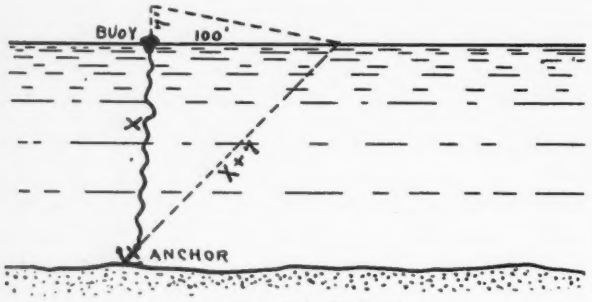
The Kind of Problems they have in Nova Scotia.

EDITOR THE PRACTICAL ENGINEER:

Here is a problem I would like you to answer in the next issue of THE PRACTICAL ENGINEER. There is a buoy floating on top of the water which is hitched to an anchor at the bottom with a slack rope, as shown in the accompanying sketch. A boat comes along and it is found that by lifting the buoy straight up for 7 feet, the rope becomes tight. They then let it down and by running to the right 100 feet, they find the rope gets tight again. The question is, how deep is the water?

Sydney, Nova Scotia. E. D. M.

If the depth of the water is taken as x, then the length of the rope is evidently $x + 7$. When the buoy is moved 100 feet to the right, the rope becomes tight, so that the three



How Long is the Rope

sides of a right angle triangle are formed by the depth of the water, the distance the buoy has moved and the length of rope. In a right triangle, the square of the hypothenuse is equal to the sum of the squares of the other two, so that we have,

$$(x + 7)^2 = x^2 + (100)^2$$

$$\text{or } x^2 + 14x + 49 = x^2 + 10{,}000$$

$$\text{or } 14x = 9{,}951$$

$$\text{therefore } x = 710.8 \text{ feet,}$$

which is the depth of the water required.—[Ed.]

Does the Lift of the Pump Enter into the Power Calculations?

EDITOR THE PRACTICAL ENGINEER:

Will you or some brother engineer answer the following question for me: What horse power will it take to raise 50 cubic feet of water to an elevation of 100 feet in one minute, the suction lift being 20 feet? What I want to know is, do you use the 20 feet in making the calculation, in which case 120 feet would be distance the water is to be raised?

Brookville, O. E. A. T.

The distance the pump is above the source of water supply must always be added to the distance the water must be forced above the pump when making power calculations. In the above case, the distance of 100 feet is the distance that the water must be elevated and 20 feet is the suction lift, so that 120 feet is the total lift or head on the pump. The theoretical horse power required is then found by multiplying the 50 cubic feet by 62.5 to get the weight of the water lifted, and this multiplied by the lift, 120 feet, and divided by 33,000, will give the horse power. That is, 50 × 62.5 × 120 = 375,000 foot pounds and 375,000 ÷ 33,000 = 11.36 horse power.—[Ed.]

Specific Heat of Saturated Steam.

EDITOR THE PRACTICAL ENGINEER:

The following rule is often given for finding the total heat in the steam: "Multiply the temperature or sensible heat by 0.3 and add to it 1115." Will you kindly explain to me where the constant 0.3 comes from?

Fort Adams, R. I. A. R.

To raise the temperature of one pound of water one degree, one heat unit is required, but to raise the temperature of saturated steam one degree only 0.305 heat units are required, or in other words, 0.305 is the specific heat of saturated steam. The 0.3 in the above rule is an approximation of the quantity 0.305.—[Ed.]

Lehigh Council.

Lehigh Council, No. 15, A. O. S. E., of Allentown, gave their annual ball on Monday evening, April 30th. There was a large attendance and a jolly time; the affair was a complete success both socially and financially. The Committee of Arrangements were Chairman, Chas. A. Driesbach, Wm. T. Ryan and M. E. Goodman, but Mr. Driesbach who has been in the Allentown Hospital since April 18th suffering from an amputated arm was unable to be present and there were expressions of regret on all sides. Mr. Driesbach, who is a son of A. P. Driesbach, Past Grand Chief of the A. O. S. E., had the misfortune to get his arm caught between the floor and the flywheel of an engine that he was oiling and in order to save his life the surgeons deemed it necessary to amputate the arm above the elbow.

Quaker City Auxiliary.

Quaker City Auxiliary, No. 3, N. A. S. E., of Philadelphia, will give a theatre party at the Park Theatre, Broad Street and Fairmount Avenue, on Friday evening, May 25th. The attraction will be "Checkers," with Dave Braham in the title rôle. The proceeds are for the purpose of entertaining the lady visitors to the coming N. A. S. E. Convention, which is to be held in Philadelphia the first week in September. Tickets can be procured by addressing Mrs. Fred Jahn, Secretary, 1402 S. Thirteenth Street.

California State N. A. S. E. Convention.

The Third Annual California State Convention of the N. A. S. E. will be held in Fresno, California, on May 25th and 26th. California, No. 7, N. A. S. E., of Fresno, is now making arrangements to entertain the officers and delegates.

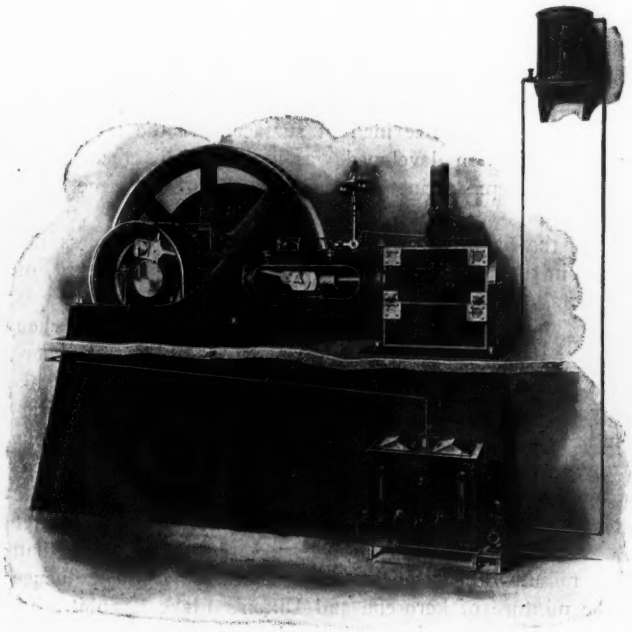
Massachusetts Convention.

The Massachusetts State Association will hold its annual convention at Newburyport, Mass., on July 13th.

The American Oil Filtering System.

Every user of lubricating oil knows that the larger portion of the oil which is bought is not consumed by the machinery on which it is employed, but passes through the bearings, drips away and is lost, except in cases where special provision has been made for gathering the waste oil by means of drip pans or buckets placed under the bearings. This waste oil frequently amounts to from 50 to 90 per cent. of the whole quantity used, but if it is gathered and filtered it can be used over and over again. In small plants the waste oil is generally caught in pans or buckets and then transferred by hand to the filter but in large plants where free-flowing oils are used, some mechanical method for using the oil over and over must be adopted.

One of these systems is shown in the accompanying illustration and is known as the American Oil Filtering System. The oil is fed to the different bearings by gravity from the overhead oil reservoir and after passing through the bearings, it is piped to the oil filter or filters in the basement and after being purified, it is again pumped to the reservoir, making the process automatic and requiring only very slight attention. The flow of oil is continuous and the machinery thus gives good results, as a liberal supply of oil can be used in all the bearings without danger of loss. An overflow pipe is attached to the pure oil reservoir, so that, if desired, the oil can be run into the filter, thus preventing overflow when the pure oil pump is in operation.



American Oil Filtering System

It is of the utmost importance in a system of this kind that the filtered oil be free from grit and dirt, otherwise the oil cups or feed pipes would become clogged up and any grit or dirt would increase the wear and friction of the machinery. With this system, the dirty oil enters the top of the filter and flows horizontally to two filtering cylinders which are each wrapped with a cloth through which the oil must pass before entering the filtering cylinder. The oil then passes through a quantity of bone black into two tubes which lead to the bottom of the filter. By means of plates attached to the bottom of the tubes, the oil is spread out in a thin film and is thoroughly washed with water and any remaining impurities in the oil drop to the bottom of the filter and can be flushed out at any time.

In cleaning the American Filter of the Unit Type, it is not necessary to shut down the whole system and disconnect the pipe connections. If more than one unit is used, all that is necessary is to shut off the flow of oil to the filter to be cleaned, allowing the other filter or filters to handle the extra amount. Where only one filter is installed, the cleaning operation is performed by removing the cloth around one of the cylinders and if the filtering material also needs to be removed, unscrew one cylinder and put in a plug, which is furnished for the purpose, into the tube, and the one cylinder will continue in operation while the other is being cleaned. By this arrangement, the filtering material can be changed without stopping the supply of pure oil and the oiling system will be in continuous operation supplying the different bearings.

The American Oil Filtering System is manufactured by the Burt Manufacturing Co., of 204 Main St., Akron, O., who will be pleased to furnish any further information desired.

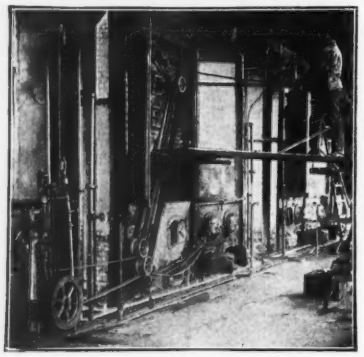
Cleaning Water-Tube Boilers.

Nearly all water used for boiler feeding purposes produces scale or incrustation upon the interior surfaces of the boiler. Unless this scale is removed before it reaches any great thickness, it greatly reduces the fuel economy and the steaming capacity of the boiler; at the same time it is a grave sort of danger, as plates and tubes covered with scale are apt to become overheated and give way under steam pressure. The water tube boiler is safer, however, against disastrous explosion than the return tubular boiler and one of its chief merits lies in the fact that the interior of its heating surface, at least in most types, can be easily inspected by removing small hand-holes at the ends of the tubes. The scale is often so hard, however, that it is practically impossible to clean the tubes by hand.

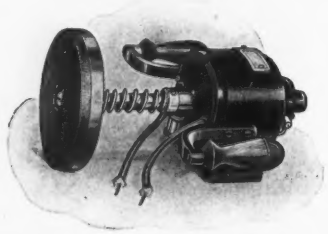
The machine illustrated herewith has been devised to make this cleaning a simple and inexpensive procedure. This machine is called the Weinland motor-driven tube cleaner and is made by the Lagonda Mfg. Co., of Springfield, Ohio. It consists of a long, jointed shaft, upon which is a cleaner head. The end of the head is a pointed screw which will bore into and break up the hardest scale. The shaft is driven by a small engine or an electric motor through shafting, or in a recent type, by a light water motor mounted directly on the end of the shaft. The Lagonda Mfg. Co. have handled many cases in which the scale filled the entire diameter of the tube. Behind the screw are large conical revolving burrs, which serve to pulverize and further break up the scale, and in the body of the cylindrical portion of the head are small burrs which are held out by contrifugal force as the head revolves. These burrs polish the interior of the tube without in the least injuring the metal.

When the tubes of a boiler have been cleaned in this manner, the small caps are replaced over the hand-holes through which the cleaner is introduced. However, the caps and seats are usually more or less rusty and rough and to make it easy

to clean them, the Lagonda Mfg. Co. has introduced the reseating machine shown herewith. Two types of these are made: one operated by water, and the other by electricity. In the former the water enters the turbine wheel at about 75 lbs. pressure and leaves the machine through a hose connection. In the electrically driven machine, the small motor is entirely enclosed and is therefore dust proof. The motors are furnished for any current or voltage desired. The cutting wheel is a flat emery stone, ¾-in. thick and 6¾-in. in diameter and, in cleaning the hand-hole seats, the operator passes the stone from tube to tube, a mere touch being sufficient to thoroughly clean and polish the faces. A spring at the back of the emery plate allows it to adjust itself to a perfect bearing upon the surface being cleaned.



The Weinland Motor-driven Tube Cleaner in action



The Lagonda Reseating Machine

In cleaning caps and nuts, the machine is held securely in any convenient position and the faces of the caps and nuts are presented to the face of the emery stone. This device does quickly and efficiently work that would engage several men many hours. In an average case, the 108 tubes of a Babcock and Wilcox boiler were cleaned in 55 minutes. The scale and dirt were not only all removed, but the surfaces were polished, permitting them to be quickly and accurately fitted. This would not have been the case had they been cleaned by using chisel and hammer.

A New Test of Dixon's Flake Graphite.

A test of Dixon's Flake Graphite was recently made by Prof. Goss, of Purdue University, to demonstrate its value as a lubricant and its mechanical affinity for metal surfaces. The manner in which it was made and the results are as follows:

In considering the manner in which the graphite under test should be applied in lubricating the rubbing surfaces of the testing machine, it was deemed desirable to use as light an oil as was available, since by so doing but little lubricating effect would be realized from the vehicle and the maximum service would be secured from the graphite. An attempt to use water proved unsatisfactory because of the tendency of the rubbing surfaces to corrode under its influence, and kerosene was finally adopted as the most convenient and the most satisfactory vehicle. Throughout the test the lubricant employed has been either kerosene, or mixtures of kerosene and Dixon's Flake Graphite.

Before attempting any work with graphite, the value of the vehicle was first determined. That this might be done, the machine was operated under kerosene lubrication for a considerable period, the pressure between the rubbing surfaces being gradually increased as they became more worn in service, the effect of the process upon the coefficient of friction being noted. This process of wearing down rubbing surfaces in the presence of kerosene involved more than 600,000 revolutions of the test machine. The heaviest pressure that could be sustained by the rubbing surfaces under this lubrication was fifty pounds per square inch of surface, and the lowest coefficient of friction developed was .00547. This record was accepted as representing the performance of kerosene as a lubricant.

After the 633,287 revolutions involved by the process described in the preceding paragraph, a mixture, by weight, of two parts kerosene and one part Dixon's Flake Graphite was made. This mixture had the consistency of thin paste when stirred, but the flakes of graphite quickly settled when permitted to stand at rest. The immediate effect of applying this mixture as a lubricant was to increase the coefficient of friction, but this in its maximum effect was momentary. Without change or any modification of the lubricating mixture, the coefficient of friction rapidly fell, first to the value given by the kerosene alone, and then to still lower limits, so that after 10,000 revolutions, occupying a period of something less than thirty minutes, the coefficient of friction, under the influence of the mixture of kerosene and Dixon's Flake Graphite, became 83.9 per cent. of that obtained from the use of kerosene alone. Conditions thus secured were continued during more than 400,000 revolutions of the test machine, for the purpose of determining beyond doubt the minimum coefficient of friction under the conditions stated, subsequently the pressure between the rubbing surfaces was increased by increments of ten pounds, until a maximum of 110 pounds per square inch had been secured. Beyond this limit lubrication failed.

The observations show that as the pressure was increased, the coefficient of friction diminished, the minimum value being .00296. The immediate effect, therefore, of adding Dixon's Flake Graphite to the kerosene was, first, to permit an increase of load from fifty pounds per square inch to 110 pounds per square inch, that is, an increase of 120 per cent., and secondly, a reduction in the coefficient of friction from .00547 to .00296, that is, a reduction of 45.9 per cent.

Having secured these results, it was next sought to ascertain the endurance of the graphite as a lubricant. This was done by removing all graphite from the machine and by rinsing all parts involved, including the rubbing surfaces, with kerosene, after which the machine was operated under a pressure of 100 pounds per square inch in the presence of kerosene alone. Under these conditions, the lubrication was aided by such

particles of flake graphite as naturally adhered to the rubbing surfaces. It was expected, however, that these particles of flake graphite would sooner or later disappear and that the conditions would return to those originally found for the kerosene alone. Each morning the rubbing surfaces were removed from the machine and all parts carefully rinsed for any particles of graphite, and the work of the day proceeded, usually to the extent of 150,000 revolutions. After eight days' running and 978,000 revolutions, no diminution in effect could be discovered. Both the capacity of the bearing and the coefficient of friction developed remained unchanged. A microscopic inspection of the surfaces showed the presence of flake graphite upon them. Whether the amount was sufficient to account for the results obtained, or whether in the earlier stages the presence of the graphite served to control the finishing of the metallic surfaces to permit them to give highly satisfactory results, are questions which cannot be determined. The probability is, however, that without the graphite the results would not have been secured.

Book Reviews.

Practical Guide for Firemen, by W. H. Wakeman. Second Edition. Size, 4½ x 6. 80 pages and 28 illustrations. Published by W. H. Wakeman, 64 Henry St., New Haven, Conn. Price, 50 cents.

This book is an elementary work for the use of young men and others who wish to learn how to operate a steam boiler and its accessories. The directions given pertaining to the instructions and suggestions for the care and management of steam boilers, pumps, injectors, traps and gauges, are based on a long practical experience which Mr. Wakeman has had along this line and are given in a practical way, and if they are carefully followed will result in much more efficient service being given to the boilers by many who undertake to work around boilers without any previous training for it, while even for many who have worked around boilers for years, it will be found to contain pointers that are useful.

The general subjects taken up include the first duties of a fireman in the morning, carrying fires and removing ashes, steam pressure and water level, boiler feeders, receivers and return traps, caring for water and steam gauges, leaving the boilers at night, incrustation and scale, accidents, preparing for inspection, boiler inspection, and the prevention of smoke.

Wiring Handbook, by Cecil P. Poole. Size, 4½ x 8. Flexible leather binding. 85 pages, 61 illustrations and 32 wiring tables. Published by McGraw Publishing Co., 114 Liberty St., New York City.

Among the many handbooks published in reference to electric wiring, the above book has the distinctive feature that instead of clothing different wiring rules with if and buts, the different conditions are considered and embodied in the tables found in the back of the book. As the author states, the book is intended for the use of wiremen who have occasion to lay out their own work, and engineers who make up wiring plans and specifications.

Mr. Poole's long experience as editor of the American Electrician has well fitted him to write on this subject intelligently and the book shows that a large amount of time must have been spent by him to condense it into its present form. Since, however, the book is intended for the practical man, it seems as if the use of the symbol C for the word current would have improved it. Otherwise the book has everything to commend it and it should have a large sale among engineering students, wiring designers and the practical man.

The tables relating to alternating current circuits are particularly valuable, as they will save a vast amount of calculation and doubt as to accuracy of any problem in alternating current wiring.

Heat and Light from Municipal and other Waste, by Joseph G. Branch. Size, 5½ x 8. 16 chapters, 300 pages, 56 illustrations and 30 tables. For sale by The National Equipment Co., St. Louis, Mo. Price, $3.00.

This book is intended as a reference book for municipalities and engineers and includes official reports from 300 American and English cities on the reduction and incinerating methods of disposing of refuse, with complete treatise on the utilization of waste heat for electrical and power purposes. It also contains reports and explanations of the different central heating plants and steam and hot water heating systems, with a description of the leading types of boilers, engines, pumps and electrical machines used in connection with such plants and systems.

The book is written by Joseph G. Branch, Chief of the Department of Boiler Inspection and Elevators and member of the Board of Examining Engineers of the City of St. Louis, Mo., and is said to be the only book of its kind which has been written on this subject. It is interestingly written and contains much data that is of popular interest.

Ventilation of Buildings, by William G. Snow and Thomas Nolan. Size, 4 x 6. 85 pages. Published by D. Van Nostrand Co., 23 Murray St., New York City. Price, 50 cents.

It has been the desire of the authors of this book to condense into a small volume, a statement of the general principles of ventilation and of their application to different kinds of buildings. It is divided into three parts which contain the general principles of ventilation, the different systems of ventilation and the ventilation of different kinds of buildings.

The book is written in a very clear style and should prove useful to any engineer who has a ventilating system to look after or who contemplates the installation of one.

Mr. George C. Cook, Dead.

The business community of New York City was recently greatly shocked by the death of Mr. George C. Cook, who died suddenly, on March 21st.

Mr. Cook was a member of the firm of Adam Cook's Sons, large manufacturers of lubricants, having correspondents in every section of this country, as well as extensive connections with Europe. Mr. Cook was well-known for his energy and business acumen and held high rank among the merchants and manufacturers of New York. His loss will be keenly felt by a very large number of friends in both the social and business world.

TRADE NOTES

EDITED BY THE ADVERTISING MANAGER

The Manufacturers' Advertising Bureau, which has been located on Liberty Street for many years, has removed to 237 Broadway, New York City.

Probably no other concern in the advertising line is as favorably and as well-known to the machinery trade throughout the United States as the Manufacturers' Advertising Bureau and its proprietor, Benjamin R. Western. The Bureau has been established since 1877, and has made a specialty of Machinery and Engineers' Supplies, advertising for many years, and is considered an authority in this line. For some time, however, the Liberty Street offices have become cramped for space and it is in order to meet the demand for more room and better facilities that the change in location has been made. The Bureau intends also to somewhat broaden the scope of its work and while particular attention will be given to advertising in the trade and technical journals, as heretofore, it will also be equipped to handle advertising in the newspapers, magazines, and all other periodicals as well.

An engineer without an indicator is in very much the same position as a tailor without a tape measure, but the engineer who has an indicator and doesn't know how to use it, is in a still worse predicament, for he is likely to ruin his valuable instrument. Mr. A. C. Lippincott, 50-58 Columbia St., Newark, N. J., has prepared a plain, simple course in indicator instruction in connection with which he lends a high-grade standard indicator and this indicator is presented to every student who completes the course, without any additional expense. These scholarships are issued either for cash or at five dollars a month. For full particulars, address, Mr. Lippincott as above.

Wilfong and Wiltbank, 420 Mutual Life Bldg., Philadelphia, report a constantly-increasing number of sales of their Copes Feed Water Regulator and Pump Governor. Wherever used, it is a strong favorite and the many testimonials which they have received indicate that, besides being a necessity in a well-regulated steam plant, it is a decided fuel saver due to the constant feed water level which it maintains. Messrs. Wilfong and Wiltbank are also agents for the New England Roller Grate Co., the Deane Boiler Tube Cleaner, and the Automatic Smoke Preventer.

Messrs. Adam Cook's Sons, 313 West Street, New York City, the only makers of Albany Grease, recently received a letter from John Liebler, engineer of the Phoenix Foundry Company, Chicago, who states: "I have found Albany Grease the best grease of any that I know, giving the very best satisfaction. During the hot and cold weather I have found no trouble whatever."

The engineer of the Seventh Regiment Armory, in the same city, states: "I find the Albany Grease Cup exactly as you claim it to be, and I am now using your Albany Grease exclusively."

R. S. Buell, supt. of the Camilla Gold Mining Company, Hancock, Col., says: "I have been using Albany Grease for the past eighteen months and must say it has given very good satisfaction."

A sample can of Albany Grease and an Albany Grease Cup will be sent free to any engineer or steam user, for trial. Address, the makers as above and mention THE PRACTICAL ENGINEER.

The man who is looking to get something for nothing usually gets it where the chicken got the axe, but utilization of waste products has been the foundation of many successes. One important feature of this brand of economy has been the conversion of exhaust steam into useful energy through the medium of a feed water heater. Frank L. Patterson & Co., 24 Cortlandt St., New York, have issued a circular which tells something of the advantages of this form of economy and describes the special features of the Patterson-Berryman Heaters, a cut of which is shown in their advertisement of page 60 of this issue. A copy of the circular referred to will be mailed to any reader.

If you want a sample can of Albany Grease and an Albany Grease Cup, free, for trial, write at once to Adam Cook's Sons, 313 West St., New York, stating that you saw the offer in THE PRACTICAL ENGINEER.

Engineers who have been in the habit of using one kind of engine or machinery oil for all their journal bearings and one kind of cylinder oil for all cylinders regardless of varying conditions, will learn something very much to their advantage by writing for one of the booklets recently issued by the A. W. Harris Oil Co., 320 S. Water St., Providence, R. I.

A new catalogue, fresh from the press, as just been received from the Buckeye Boiler Skimmer Co., 521 Colburn Ave., Toledo, Ohio. In it is described the action of water and of scale-forming impurities in steam boilers and also the operation and advantages of the Buckeye Automatic Boiler Skimmer. It contains several illustrations showing how the skimmers are connected to different types of boilers and also shows the floating skimmer and enumerates its many advantages over the old style stationary skimmers. A feature of this new catalogue worthy of notice is the large number of enthusiastic letters from steam users who have the skimmers in use. A copy of this new catalogue will be mailed to any reader of this journal upon request.

The Locke Regulator Co., of Salem, Mass., report that they have recently closed contracts for or made installations of the "Locke" Automatic Engine Stop and Speed Limit System with the following Companies, through their New York representatives, W. A. Garrett & Co., 180 Fulton St.: The American Thread Co., New York City, eight Stops (these eight Stops will protect 13 engines); La Crosse Plow Co., La Crosse, Wis.; Majestic Hotel, Atlanta, Ga.; Howard Bros., Worcester, Mass.; Dingley-Foss Co., Auburn, Me.; Chattanooga Plow Co., Chattanooga, Tenn.; Hooven-Owens-Rentschler Co., Hamilton, Ohio (two Engine Stops); Brown & Sharpe Mfg. Co., Providence, R. I.; Aldrich Mfg. Co., Providence, R. I., two Engine Stops (these two Stops will protect four engines); Gordon Bros., Philadelphia, Pa.; Covington City Water Works, Covington, Ky. (two Engine Stops); Stanley Rule & Level Co., New Britain, Conn.; B. F. Sturtevant Co., Hyde Park, Mass.; Joseph Funke Co., La Crosse, Wis.; Providence Engineering Works, Providence, R. I.; Bierhauer Brewing Co., Mankato, Minn.; Fort Orange Paper Co., Castleton-on-Hudson, New York; Warren Foundry & Machine Co., Phillipsburgh, N. J. (two Engine Stops); P. & F. Corbin Co., New Britain, Conn.

They also report that they have received second orders from the Star Worsted Co., Fitchburgh, Mass.; Emmons Loom Harness Co., Lawrence, Mass.; Quincy Market Cold Storage Co., Boston, Mass., and a second order from the De Lamar's Copper Refining Co., Chrome, N. J., for four Stops.

The new office building of the Union Pacific Railroad Co., Omaha, Nebraska, is to be equipped by the B. F. Sturtevant Co., of Boston, Mass., with a complete heating, ventilating and air cleansing installation, which will comprise a fan to be driven by a motor, a heater, a tempering coil, and a special air washer.

The General Specialty Company, of 75 Carroll St., Buffalo, N. Y., are having a heavy sale on their boiler cleaners, the "Demon" and "Torpedo." Although they have recently doubled their facilities, they find it impossible to keep

For Sale The Process and Formula for Manufacturing Granual and Plastic Metallic Packing. **No Machinery required. Babbitt Ladle. Babbitt Metal and Graphite. That is all.** Ideal Metallic Packing Co., 419-421 MacKubin St., St. Paul, Minn

Wanted A few good and competent engineers along the Ohio, Mississippi and Kanawah Rivers, to sell the best thing on earth. This can be done after working hours and between times. Address, J. L. TILLMAN, 521 Colburn Street, Toledo, Ohio.

Wanted Salesmen traveling among engineers to sell the France Metallic and Fibrous Packings. Good inducements on unoccupied territory, Address FRANCE PACKING Co., Tacony, Phila., Pa.

PATENTS Watson E. Coleman, Patent Attorney, Washington, D. C. Advice free. Terms low. Highest ref.

PATENTS Procured ISEDORE S. PRENNER, E.E. Attorney-at-Law, Solicitor of Patents, Consulting Engineer, Law, Patent and Engineering Cases. Room 1108 Betz Building, Philadelphia.

PATENTS PROMPTLY SECURED. Highest references from prominent manufacturers. Write for Inventors' Hand-Book, SHEPHERD & PARKER, 186 Deitz Building, Washington, D. C.

even with their orders. Inasmuch as these devices are usually purchased only after trial, it speaks very well of the practical merits of these machines. This Company issues some highly interesting, illustrated printed matter on their devices, which is sent free on request.

A prominent Chicago capitalist is now building a new type engine in Philadelphia, which it is said will show a very high efficiency. It is to be unique in design, combining the principles of the reciprocating, rotary and turbine engines. It is said to have received the approval of several of the leading local engineers. The inventors are Franklin MacIndoe and Peter T. McGlynn. Mr. McGlynn is superintending engineer for Strawbridge & Clothier's big department store and Mr. MacIndoe is chief engineer of the same firm's Race Street warehouse. Both men are well-known and popular engineers. It is expected that the new engine will be completed about June first, when it will be installed at the Strawbridge & Clothier main power plant for a thorough working test of several weeks' duration. It will be connected direct to an arc machine running a circuit in the store. The engine, which is to be reversible, will occupy floor space, 36 x 42 inches, and is expected to develop 40 horse power.

If you have a water-tube boiler of any type write to Lagonda Mfg. Co., Springfield, Ohio, and ask them to send you catalogue No. 21.

How many readers took advantage of the splendid offer made by the Peerless Rubber Co., on page 37 of our April number? Those who have not yet done so should get busy and send in their list at once, before the premiums are all gone. They are worth having.

Dean Brothers "Atlantic Type" boiler feed or pressure pumps are interestingly described in a new pamphlet just issued by Dean Brothers Steam Pump Works, Indianapolis, Ind. The "Atlantic Type" pumps were first built for marine service but with certain modifications they have proved very desirable for stationary service in power plants where only high-grade machinery is desired and where there must be no shutdown. In fact, there are many plants where this type of pumps would fill the bill to a nicety, for they possess some distinct advantages. A copy of the new pamphlet will be mailed to anyone interested mentioning this paper.

Every engineer knows the value of having good firebrick for boiler fronts, side walls, bridge walls and back arches. "Steel Mixture," which is designed especially for these purposes, will stand the hardest service for years. The whole construction is tongued and grooved so that when once put up it is as solid as a rock. Don't fail to write to McLeod & Henry Co., Troy, N. Y., when you have any trouble with your firebrick.

The Wilkinson Manufacturing Co., of Bridgeport, Pa., are the manufacturers of a stoker which burns the very finest sizes of anthracite coal with marked economy. They are at the present time equipping 3500 horse power boilers for the Waldorf-Astoria Hotel with their 1906 Peerless Stoker, which is specially designed for that class of service. Their new catalogue describing this stoker will be sent upon request.

A fine new catalogue just issued by Jas. McCrea & Co., 63 West Washington St., Chicago is devoted to steam pipe repairs and steam specialties, including a patent flue cleaner rod, a boiler tube cutter, a drilling machine made especially for use in the power plant, a gasket cutter, a steam trap and a feed water regulator. Mailed free to those who write—the catalog we mean.

One of the most annoying and wasteful things that can happen around a power plant is the leaks that are constantly occurring at pipe joints, and these usually occur in places that are difficult to get at or on lines that cannot conveniently be put out of service for repairs. Numerous devices have been made for the purpose of remedying such leaks, but the best of these that we have seen, and the simplest, is the Smith Clamp. This device is as simple as it can be made and is highly efficient. We have seen it used in many places and always with instant and perfect results. They are manufactured by W. Clifford Smith, 138 North Sixth St., Philadelphia, Pa. Mr. Smith issues a circular showing cuts and describing his clamp, which he will mail upon request.

The capital of the Standard Roller Bearing Company, Philadelphia, has been increased from $2,000,000 to $3,500,000. This increase in their capital has been required to provide for an enlargement in their factory and equipment. A four-story factory, 150 x 200 feet, will be erected immediately for the manufacture of Annular Ball Bearings, on which this Company holds basic patents.

During the past year, the Standard Roller Bearing Company have equipped with machinery a four-story building, 95 x 200 feet, and have also built and equipped an iron foundry, 70 x 150 feet, two stories in height; hardening and tempering building, 70 x 150 feet, and a crucible steel castings plant, 60 x 100 feet. With the new building which will be erected immediately, the Company will employ over 1000 hands in the manufacture of Steel Balls, Ball Bearings, Roller Bearings, Automobile Axles and Annular Ball Bearings.

The Garlock Packing Co., 604 Arch Street, Philadelphia, are Eastern Agents for the Youngstown Steam Trap.

GRAPHO
SOMETHING NEW
A new preparation for enriching oils.
Will suspend in oil.
No more Hot Journals.
Engineers who have tried same claim it to be the best yet.
SEND FOR SAMPLE
A trial will convince you
AGENTS WANTED
GRAPHO MFG. CO.
Cor. Frank and Commercial Sts.
ROCHESTER, N. Y.

F. A. Genth, Jr.
Analytical and Consulting Chemist
222 WALNUT STREET
Telephone **Philadelphia**

NEW EDITION
Care and Management of
Electric Power Plants
By NORMAM H. SCHNEIDER
thoroughly revised and enlarged, with many new diagrams, tables and 137 new illustrations.
A practical book for the practical man, containing a fund of valuable information for those who have to do with Electric plants.
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Storage Batteries
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Handsome Full Limp Leather, - $2.50
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123 P. E. Liberty St., New York

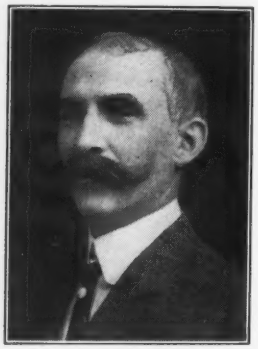
The Smith Pipe Clamp

Stops The Leak Every Time
A complete set for every size of pipe in your plant will save many a dollar. Quickly applied while pressure is on the pipe WE GUARANTEE TO STOP THE LEAK. Steel or brass, all sizes, ¼-inch to 20-inch. No trouble to send further information.
W. CLIFFORD SMITH
138 N. SIXTH STREET
PHILA., PA., U. S. A.

Will Increase Capital and Erect New Building.

Reprinted from Domestic Engineering issue of April 7th, 1906

So rapidly has success come to The D. T. Williams Valve Co., of Cincinnati, that a story of it seems improbable. From conception of a business of his own to a realization of that conception, and the organization of a Company bearing his name, may or may not have been a long time in the case of D. T. Williams; I have never asked him as to that; but from the date of its organization—it really seems



D. T. WILLIAMS, President

but a few months ago—to today when I am authorized to make this announcement of its important project, does not seem long enough in which to achieve success. You know success is a coy maiden when wooed by some men, and only yields after a long and diligent courtship. But with Dave Williams she acted as did the coon for that other Dave, and came right down. Organized in December, 1904, The D. T. Williams Valve Co. entered the field determined to make a success, and already—within fifteen months—that success is so large that at the annual meeting this month the Company will

J. W. TARBILL, Treasurer

be called to increase its capital stock from $100,000 to $250,000 by issuing common stock. This action is necessary because of the extraordinary growth of its business. I am also able to announce that the Company has perfected arrangements for purchasing from the Hunt estate a piece of land on Hunt Street 125 feet wide and running to a depth of 247 feet to a switch on the C. L. & N. Railway. The purchase price is $33,000, and on this ground a building will be erected after plans which Mr. Williams is now perfecting with his architect. The site is regarded as an ideal one for the business. The building will cover the entire lot and will be four stories high, with basement and sub-basement, the latter opening at the rear on a level with the railway. It will probably be of reinforced concrete, although mill construction is being considered.

The principal feature of the plant will, of course, be the brass foundry, for casting the Company's line of valves and automobile trimmings and specialties. The finishing department, storage and shipping departments and offices will occupy the remainder except the first floor, which will be on the level of Hunt Street, which will be an immense garage.

D. T. Williams is the president of this aggressive Company, and I am sure I do not underestimate his associates in the least when I say that his popularity with the jobbers of the country accounts for much of the instantaneous success achieved by his Company. For sixteen years before going into business he had

FRANCIS X. PUND, Vice.President

charge of The Lunkenheimer Company, of Cincinnati, and every one knows how successful his management of that business was, it developing under his care from a small Company into a very large one. He is personally acquainted with the principal dealers of plumbing, heating and mill supplies of the entire country. He knows the conditions of trade under which the dealers do business, and he has adopted a policy which he believes is in accord with their desires. No quantity restrictions or requirements are placed upon buyers, they being permitted and encouraged to buy in such quantities as the character of their business requires. Mr. Williams believes that if the quality of his goods is what it ought to be the demand for them will govern the amount purchased by the jobber.

Francis X. Pund is the vice-president of the Company. Mr. Pund also brings years of experience to the business, but while Mr. Williams' experience was in the manufacturing end of the business, Mr. Pund's has been in the supply end, he having been with that singularly successful institution, The Queen City Supply Co., of Cincinnati, for many years. His ripe knowledge of the supply business thus supplements Mr. Williams' experience.

F. L. Swanberg is secretary of the Company. For four years Mr. Swanberg was assistant superintendent of The Lunkenheimer Co., and is thoroughly conversant with the manufacture of brass goods.

Harry J. Ernst is manager of the advertising and sales department and brings to this depart-

F. L. SWANBERG, Secretary

ment not only the experience gained while he was on the road for several years for The Lunkenheimer Co., but a natural aptitude for getting orders.

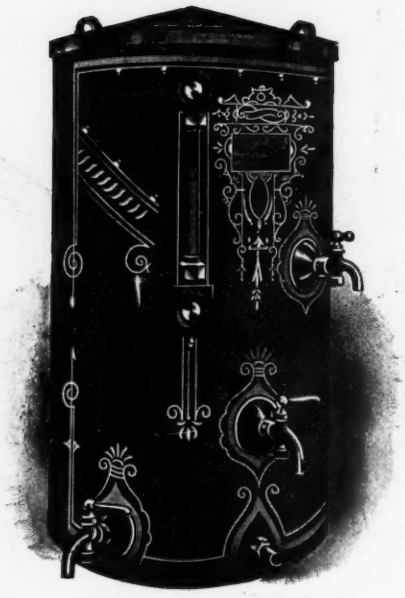
J. W. Tarbill is the treasurer of the Company. He occupied the position of cost clerk and traffic manager for The Lunkenheimer Co., and is thoroughly informed in his line.

All the other departments, including the brass foundry, finishing shop, tool room and iron department are in charge of thoroughly competent and experienced men to whom, as well as to the officers of the corporation, Mr.

HARRY J. ERNST, Adv. and Sales Mgr.

Williams ascribes much of the success attending the building of a new business. To the many friends of Mr. Williams, scattered from one end to the other of this great country, we are certain these announcements as to the success of his Company in its brief past, its policy in the future, and the photographs of him and his associates, will prove timely and interesting.

Domestic Engineering



(**Recently ordered 12 more**)

"They Have Given Entire Satisfaction."

This is what the Atlas Portland Cement Company says of the Cross Oil Filter.

JUST READ THEIR LETTER:

Northampton, Pa., Mar. 21, 1904

THE BURT MANUFACTURING CO.,
AKRON, OHIO

GENTLEMEN:—

We have your favor of the 15th inst., and in reply would advise that we have twenty-one of your large Cross Oil Filters installed at our various plants, and they have given entire satisfaction. It was only quite recently that we sent you an order for additional filters which we were influenced to do, owing to the satisfaction which previous filters ordered from you have given us. Yours truly,

ATLAS PORTLAND CEMENT COMPANY.

Dic. L. H. R.—S. L. H. REPASS, Purchasing Agent

The Cross Oil Filter will easily save 50 per cent in your oil bills. Try it for thirty days—if, in that time, it fails to do all we claim for it, we will take it back without a murmur.

REPEAT ORDERS

constitute a large proportion of our business. If the "Burt" Exhaust Head were not the best obtainable, no concern would purchase it more than once.

Marinette, Wis., Mar. 15, 1902

THE BURT MANUFACTURING CO.,
AKRON, OHIO

GENTLEMEN:—

Please send us one 10 inch "Burt" Exhaust Head, same as shipped us December 20th, 1901. We assume the price will be the same. We are charmed with the efficiency of the one put in by us and must have another.

Please ship as soon as possible. Yours etc.,

N. LUDINGTON COMPANY.

Our New Catalog, fully describing our complete line of Oil Filters and Exhaust Heads, is gladly sent to anyone interested.

The Burt Mfg. Co.

Largest Manufacturers of Oil Filters in the World.

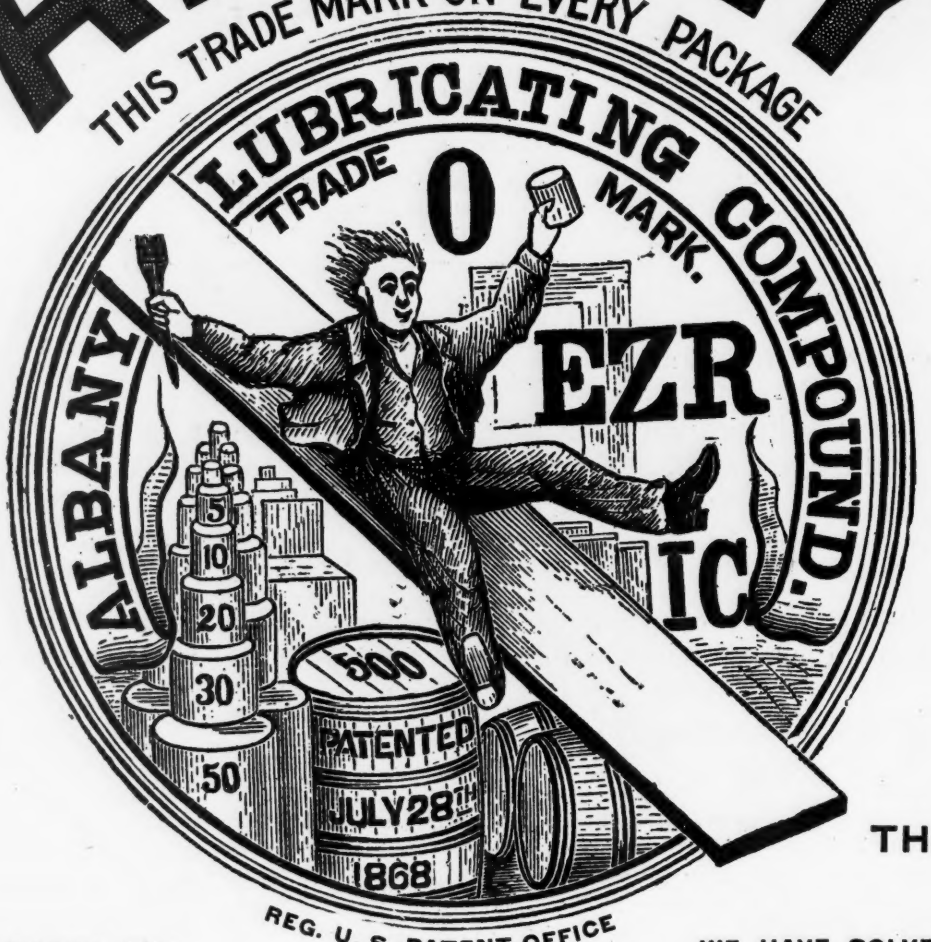
204 Main Street, AKRON, OHIO, U. S. A.

Also Supplied by Engine Builders, Dealers, and Power Contractors

Carried in stock by Shelby & Co., 66 Leonard Street, London, E. C., England, Sole Agents for Great Britian.

ALBANY

THIS TRADE MARK ON EVERY PACKAGE



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of Oil Hole from
of Tap to Journal,
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the same is to be u

THE U. S. GOV'T
OF LUBRICA

WE HAVE SOLVED THE PROBLEM OF ECO

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The Singer Manufacturing Co.
Chicago, Burlington & Quincy R. R. Co.

Cost of using Oil
Cost of using ALBANY GRE

ONLY MADE

ADAM COOK

313 WEST STREET.

RE IS ONLY
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ease with an Albany
ease Cup free of
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Oil Hole from Top
Tap to Journal, and
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same is to be used.

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ROBLEM OF ECONOMICAL LUBRICATION

GREASE

THIS TRADE MARK ON EVERY PACKAGE

REG. U. S. PATENT OFFICE

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The Pope Manufacturing Co.
Delaware, Lackawanna & Western R. R.
Long Island Railroad Co.
Lehigh Valley R. R. Co.
American Car & Foundry Co.
American Locomotive Works.
The Western Electric Co.
The General Electric Co.

NY GREASE
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OOK'S SONS
STREET. NEW YORK

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WARLEY'S BOILER COMPOUNDS

Are prepared from THE HIGHEST GRADES OF CHEMICALS ONLY.
Do not contain anything of an injurious nature to iron or anything in connection with steam plants.
Are GUARANTEED TO FREE BOILERS FROM SCALE AND PREVENT CORROSION and PITTING
Can be used with perfect safety in any kind of steam boiler or plant.

Engineers and Steam Users who have used many other Compounds without success should give Warley's a trial, and they will be surprised and pleased with the results given.

MANUFACTURED ONLY BY

No. 221 South Front Street **THOS. C. WARLEY & CO.** **PHILADELPHIA, PA.**

Circulars descriptive of our Compounds will be furnished cheerfully upon request. Telephone Connection.

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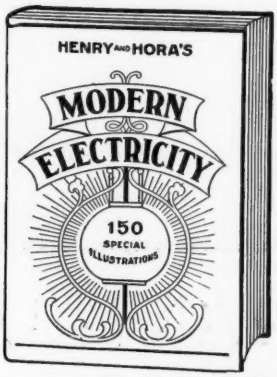
Modern Electricity



At last a thorough Electrical Text Book has been produced that cannot fail to meet the requirements of the Artisan, Student, Electrical Engineer, Inventor, and all who are interested in this Mysterious Force.

Summary of Contents:

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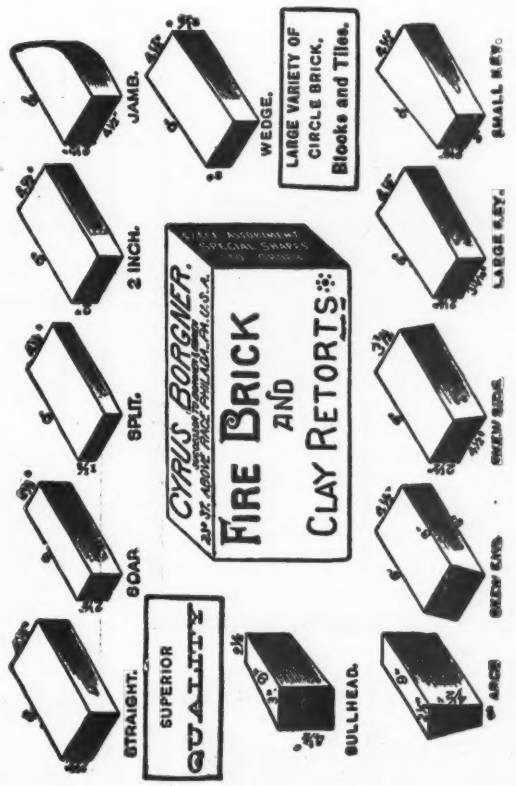

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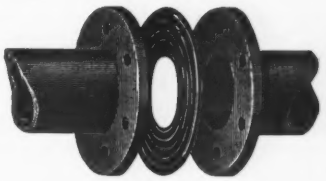

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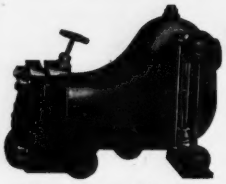
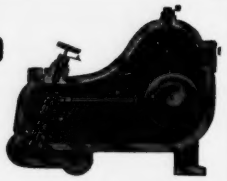
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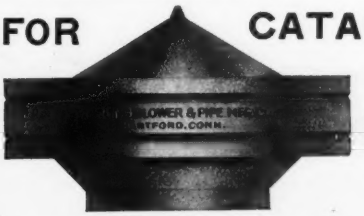

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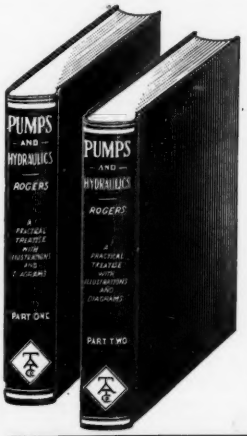

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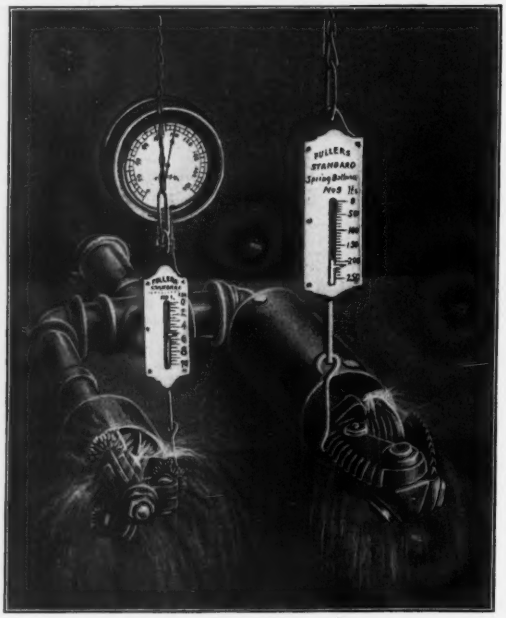

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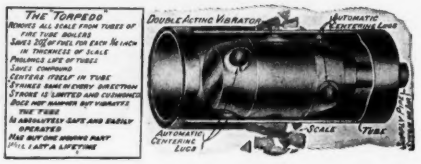
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SCALE
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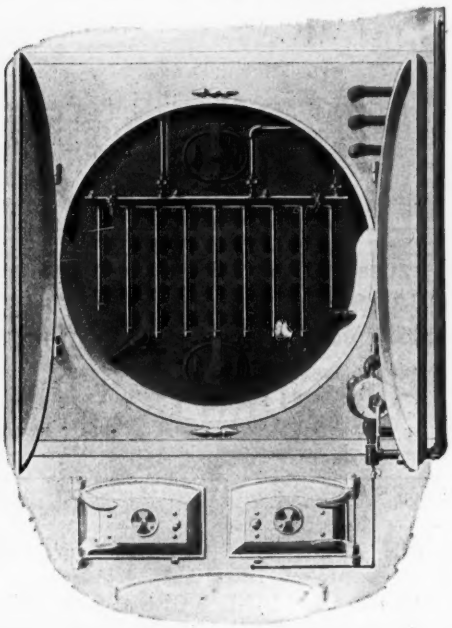

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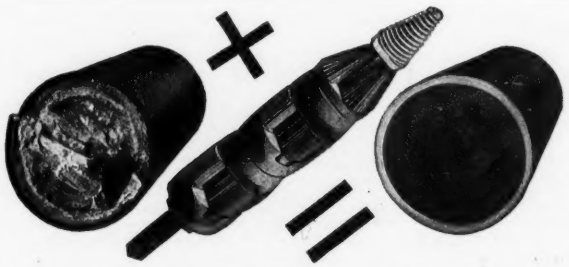

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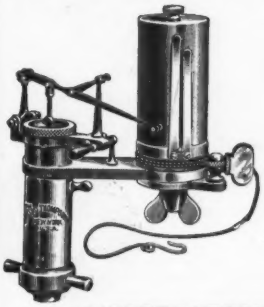

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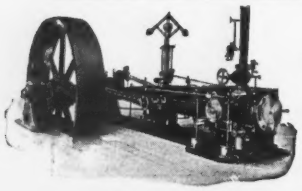

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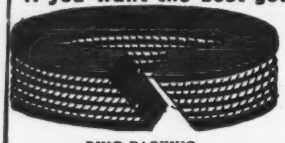

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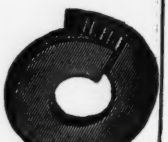

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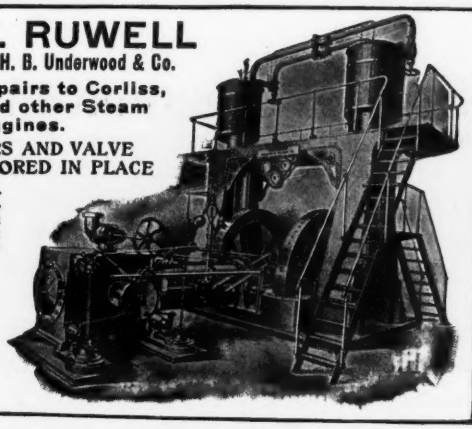

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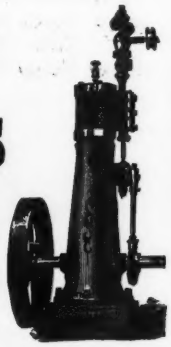

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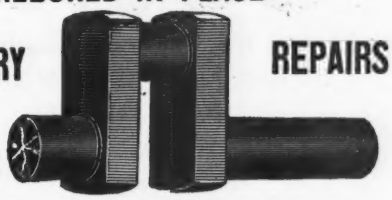
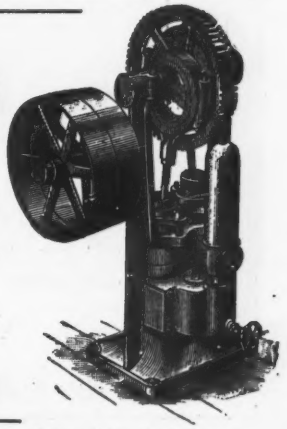
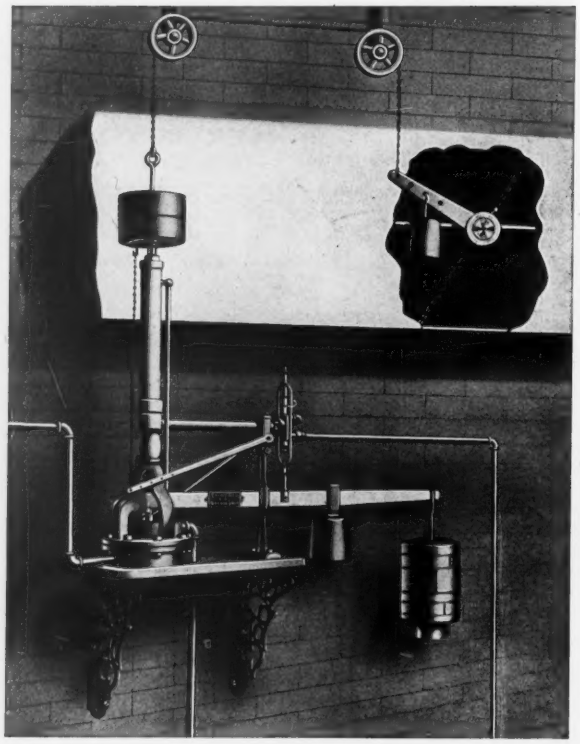


General Engineering Co.
Engineers, Boiler Makers, Blacksmiths
J. GEMMELL, Supt. Phila., Pa. 764 Swanson St.

AUGUST BLIND D. H. KRUGER
ENGINE ROOM REPAIRS
We send Portable Tools and Expert Machinists to **REBORE** Cylinders, Valves, Ports, Straight and Taper Crank Pin Holes, etc., Reface Flat Valves, Turn Off Crank Pins.
General Repairs to Corliss, Green, Buckeye, and all other types of Engines.
The Kruger & Blind Co., Machinists *and* Engineers
Late with WM. L. SIMPSON
Keystone and Bell Telephones Send for Booklet
511 and 513 Master St., Philadelphia



Builders of Keystone Belt Pumps



Bulletin No. 1

Special Announcement

The first and only genuine Hydraulic Damper Regulator. All others are worthless imitations. Over 10,000 in use—152 sold to cotton mills in Fall River alone. Get our prices before ordering a mongrel. We warrant our machines for 5 years, and guarantee them for 20 years or your life time. They will outlast the boilers and entire steam plant.

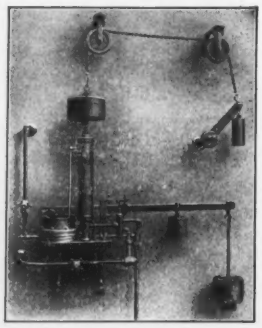
We Are Selling Them At Cost, so you need not waste any more money on cheap imitations. We have cut their prices and will give the public the benefit of this great invention. Their prices will look like a mountain when compared with our figures.

Write for cut prices on Damper Regulators. We make a tempting offer to the jobber and trade in general. Write to-day and get in on the ground floor before the rush.

Locke Regulator Company - - Salem, Mass.

$50.00

PATTERSON (PERFECTED) GRADUATED SCALE BEAM HYDRAULIC DAMPER REGULATOR (NO. 2 MODEL)



"We have won first place in Hydraulic

Damper Regulators

Selling by Giving such Value as this for $50."

Scientifically Designed, Simple in construction.

Will handle 1 to 20 Dampers on (1) pound variation of boiler pressure.

Sent anywhere on 30 days trial.
Satisfaction guaranteed or no pay.

Patterson Manufacturing Co.

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ZENA

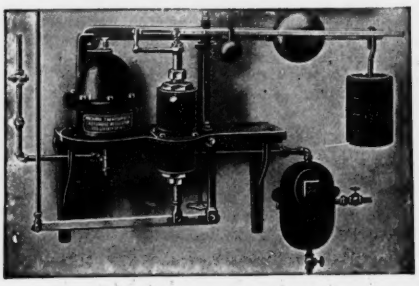
BEST HIGH-GRADE HIGH-PRESSURE PACKING

The toughest, most elastic and most pliable packing made. A few turns used in connection with any packing you now have will improve that packing greatly.

Try it and you will always be a friend of Zena.

WRITE TO ME AND ASK ABOUT IT

RANDOLPH BRANDT, 36 Cortlandt St., New York



The Thompson Damper and Pressure Regulator is equipped with the very latest and best improvements, and positively insures uniform steam pressure, therefore it saves coal. Don't buy a regulator until you investigate the Thompson, it is the

MOST PERFECT ACTING REGULATOR MADE.

RICHARD THOMPSON & CO., Sole Manufacturers
126 LIBERTY ST., NEW YORK, N. Y.

Western Agents Advance Packing and Supply Co. 55 So. Canal St., Chicago Ill.

DEARBORN LABORATORIES

Have introduced Chemistry in the scientific, correct and economical treatment of boiler waters. Gallon samples of the feed water are analyzed from time to time, and the treatment furnished constantly meets requirements in the prevention of scale, corrosion, foaming or such troubles as each particular water may produce.

DEARBORN TREATMENT will positively keep your boilers clean and well preserved.

DEARBORN TREATMENT is made on such lines that the quantity required to treat each thousand gallons of water is small, consequently its use is economical.

You are further assured that a house of chemical standing will use no materials that in themselves would be injurious to your boiler plant.

If you have not adopted Dearborn Water Treatment as thousands have done, send us gallon of water for analysis and proposition.

DEARBORN DRUG AND CHEMICAL WORKS

WM. H. EDGAR, Founder

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BIRMINGHAM, First National Bank Building
CINCINNATI, Union Trust Building
BUFFALO, Morgan Building
BOSTON, Oliver Building
PITTSBURG, House Building
INDIANAPOLIS, IND.

DETROIT, Majestic Building
ST. LOUIS, Security Building
KANSAS CITY, New York Life Building
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DENVER, Boston Block
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EUREKA PACKING

GENUINE EUREKA.

Write it in the order and use the word Genuine.

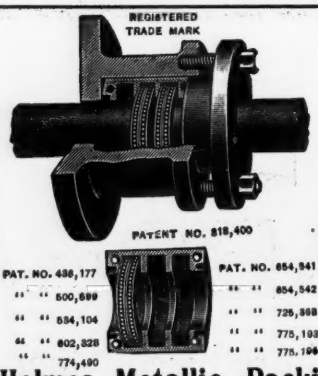
Eureka Packing is made to fill the packing wants of to-day. There is no soft packing made as conscientiously as Eureka Packing, as good as Eureka Packing, or that is sold at less price than Eureka Packing.

We say the word Genuine because we want you to buy and use Genuine Eureka, the only soft packing in which long fibre flax is used and in which a true, pliable, resilient rubber core is placed so that it never comes in contact with the rod. It means that once the stuffing box is packed with Eureka, that the rod may be even bent, sprung, scored or marred, and still it will remain steam tight because of the elastic properties of Eureka Packing.

Ask us about

Robertson-Thompson Indicators,
Hine Separators, Victor Reducing Wheels,
Spencer Damper Regulators.
Willis Planimeters, Feed Water Heaters,

Jas. L. Robertson & Sons,
Incorporated
205 Fulton Street, NEW YORK

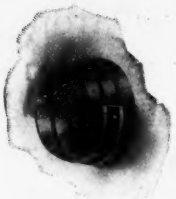


Holmes Packing

is now recognized as being superior to all others and is a common name among engineers

First cost, only cost.
Guaranteed 3 years. No Cutting. No Friction.
Less Oil.
Thirty Days Trial.
Send for Catalogue H.

Holmes Metallic Packing Co. WILKES-BARRE PENNA.



The United States Metallic Packing Co.
PHILADELPHIA AND CHICAGO

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We have added several new and useful articles to our list of premiums for procuring subscribers to The Practical Engineer and we want all our engineer friends to get up a Club. Write for circular The Practical Engineer, 46 N. 12th St., Phila., Pa.

FREE To Any Engineer

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Also 500 other things including every article, tool or device an engineer may want. For Free premium list and full particulars regarding this remarkable offer, fill out and mail us the coupon below.

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State Road, Tacony, Philadelphia
MANUFACTURERS OF
METALLIC, FIBROUS AND SHEET PACKINGS

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Date,_____1904.

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State Rd., Tacony, Philad'a.

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Kindly send me premium list and full particulars regarding the indicators and other articles you are giving to engineers.

My name is_____
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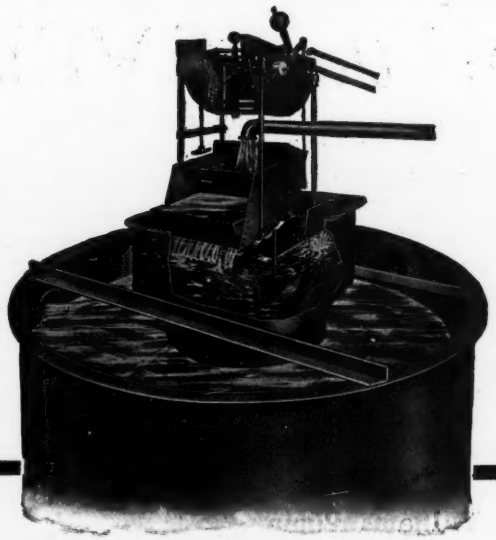
Give Complete Address.



American Water Softener

Would you swallow poison because you know the Antidote?
Then why do you feed Hard Water to your Boilers?
Boiler Compounds and Cleaners are only Antidotes and a Boiler, to do its proper duties must first be rid of Poison and Antidote alike.

OUR CATALOGUE GIVES A FEW HINTS

AMERICAN WATER SOFTENER CO.

1002 Mutual Life Bldg., Philadelphia, Pa.
302 Outlook Bldg., Columbus, Ohio

Climax Lubricator

THE LATEST IMPROVED FORCE FEED LUBRICATOR

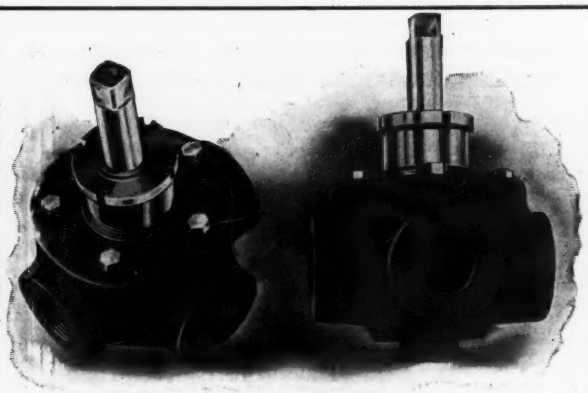
SMALL DROPS FED OFTEN

"ACCESSIBLE"

Send for Circular

CLIMAX LUBRICATOR COMPANY
3 Appleton Street, Boston, Mass.

Philadelphia Representative
L. BANCROFT MELLOR
14 S. Fourth Street, Philadelphia



THE McCARTHY

Four-Way Valve

is used to take the place of the old four-way cock which as every engineer knows, wastes more steam than it takes to do the work required of it.

The McCarthy Valves have been in use for seven years under the most severe conditions and have never leaked. They are easy to work and require no packing.

They can be used to advantage for elevators, hydraulic and steam lifting machinery and are used extensively in all the largest iron and steel plants throughout this Country and Europe.

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Also Manufacturer of the McCarthy Exhaust Relief Valve and the McCarthy Universal Union.

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PRACTICAL

Ammonia Refrigeration

By REDWOOD

is a Practical Handbook for Engineers in charge of Ice Plants. It contains 146 pages of good reliable information including numerous Tables and is fully illustrated.

The Tables alone are worth the price of the book for reference purposes. Price, $1.00 or will be **sent free** as a premium for a Club of Three Subscribers to The Practical Engineer at Fifty Cents Each.

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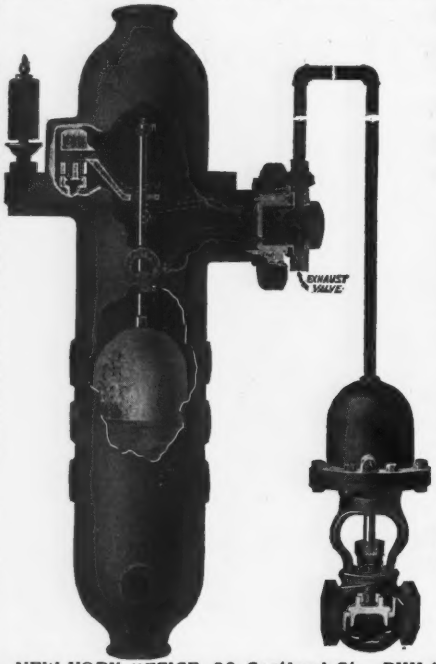
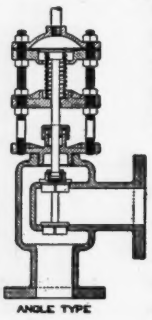
IT PAYS TO BE ON *the* LEVEL

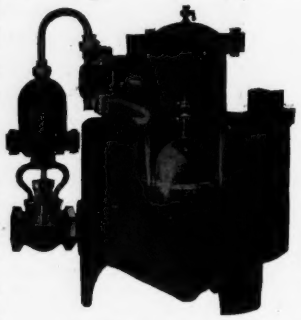
in all things, and especially in feeding your boilers because a uniform water level means saving of fuel, saving of repairs, saving of oil and a distinct improvement in your entire steam plant.



Williams Safety Feed Water Regulators are used in over two thousand of the leading and largest power plants in America. They control the admission of the feed water with the certainty of destiny and save their original cost every few months.

The Williams Steam Operated Trap has a greater delivery and a more positive discharge than any other trap. It blows the water out like a shot and closes just as quick. It will do the work of three or four ordinary traps and do it better.





The Williams Pump Governor is the biggest winner that has came out in the engineering field for many a day, since we first offered this governor to the public more of them have been sold than of all other makes combined.

OUR LARGE NEW CATALOGUE IS YOURS FOR THE ASKING.

Williams Gauge Co.

PITTSBURG, PA., U. S. A.

NEW YORK OFFICE, 39 Cortland St. PHILADELPHIA OFFICE, 710 Girard Building. BOSTON OFFICE, 610 Tremont Building.

YOU BE THE JUDGE!

LET US SEND YOU ONE OF OUR

Copes Feed Water Regulators and Pump Governors

No Floats to Clog

No Diaphragms to Blow Out

No Springs to Break

TRY IT

and if doesn't save you coal, packing, labor, increase the life of your boiler and eliminate danger, it won't cost you one cent.

Pays for Itself in a Few Months

Can't Get Out of Order

Works by Expansion and Contraction

YOU CAN'T BEAT NATURE

CATALOGUE FOR *the* ASKING

Wilfong & Wiltbank

420 Mutual Life Building **PHILADELPHIA, PA.**

AGENTS FOR NEW ENGLAND STATES

The New England Roller Grate Co., Whitney Building, Springfield, Mass.

This Knife FREE

CUT OUT—A SAMPLE OF SCALE FROM YOUR BOILER, THEN
CUT OUT—THE COUPON AND MAIL IT TO US WITH THE SCALE

Then we will send you—free of charge—a high grade pocket knife—two blades—actual size of illustration; also some information regarding

Lord's Boiler Compounds

and how they remove scale. The superiority of our products is proven by the growth of our business. We now operate the largest plant in the world devoted to the analysis of scale and the preparation of water purifying chemicals.

CUT OUT—the extra work caused by scale.

CUT OUT—burning too much coal.

CUT OUT—experimenting with ready-made boiler compounds.

CUT OUT—and mail this coupon to-day.

The Geo. W. Lord Co.
2238-50 N. 9th Street,
Philadelphia, Pa.

Gentlemen: I am sending you a sample of scale from our boiler. You are to analyze it, and send me, free of charge, a certificate of analysis and the Knife

*Number of boilers in use*_____
*Capacity of each boiler*_____
*Frequency of cleaning boilers*_____
*Frequency of opening the blow-off during working hours*_____ *River or other source of water supply* _____
Boilers are used about _____ *hours out of 24*
*Coal burned per day*_____
Water evaporated per day _____
*Name*_____
*Street and Number*_____
*City*_____ *State*_____
Firm's Name _____
Date_____

April Prac. Eng.

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One of the greatest changes that is taking place in power plant operation is the change from oil to grease as a lubricant. Engineers are rapidly learning that a good grease is a better and safer lubricant than a good oil. A decade hence there will be very little oil used in power plants.

We do not claim that **Philadelphia Grease** is "just as good as some other grease." We do not even claim that it is "just as good as the best." What we do claim is that it is **better** than any other grease ever offered to the power using public, and we are proving it every day in actual working tests under every possible condition of power plant service. Please bear in mind that this is not an ordinary grease such as you may have used before, but it is a highly refined lubricant pure enough to lubricate a watch, and to prove it, will send you for trial a

Large Sample Can Of Grease Free of all Cost

Philadelphia Grease is a highly refined lubricant made by an improved dry heat process from a special combination of the best quality of oils. It has a fine, close, even grain and a rich natural color which distinguishes it instantly from inferior greases. It is pure enough to lubricate a watch and cheap enough to use on any kind of machinery or line shafting. Don't put it off, write today for sample can.

One pound of Philadelphia Grease will go further and do better work than three to four gallons of oil or from three to five pounds of any other grease ever made. It is better than oil at any price and far cheaper and it is so much better than other greases that after a trial you will never be satisfied with any other.

A trial cost you nothing and will save labor and money.

The Philadelphia Grease Mfg. Co. Bourse Bldg., Philadelphia
97 High St., Boston, Mass.

ROBERTSON-THOMPSON INDICATOR

to the success of an engineer in his profession is often due to the mechanical appliances which he chooses to push him front and foremost in his profession.

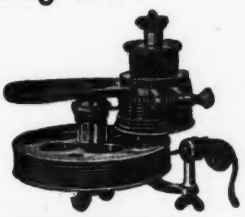
A ROBERTSON-THOMPSON INDICATOR

is absolutely necessary to the engineer who desires to fit himself for a better position and more pay. It means it will give him absolute control of his engine, tell him things that he must know, enables him to control economy and to produce results that count. We sell them on easy terms to engineers.

A Victor Reducing Wheel

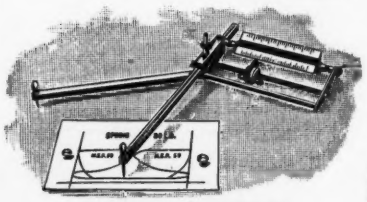
coupled with the indicator, is a great aid to the engineer. It reduces stroke to card size, and the newly patented spring tension device will be appreciated.

Sold on as easy terms as we sell our indicators.



VICTOR REDUCING WHEEL

One thing more,



THE WILLIS PLANIMETER

A Willis Improved Planimeter

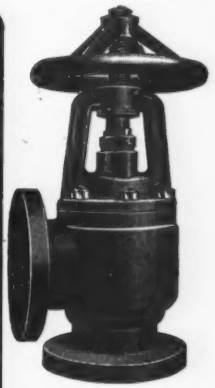
is a nice addition to your indicator outfit—one works with the other. It enables an engineer to read M.E.P. without complex calculations or waste of time. Sold on remarkable prices to engineers.

We will be glad to give you information regarding our Hine Separator, Spencer Damper Regulator, Robertson Feed Water Heater and Eureka Packing.

Jas. L. Robertson & Sons (Incorp.)
205 Fulton Street, NEW YORK

The installation of a

Foster Automatic Non - Return Stop Valve



Foster Non-Return Stop Valve

will prevent disastrous disaster which is likely to occur from the flowing back of steam into a boiler that has been out of use and is cut into line before the proper pressure has been reached.

This valve is a positive safeguard. It never sticks at the vital moment. Although automatic in action, it may be closed by hand when desired.

For other details of this valve as well as other Foster Valve Specialties, look through a Foster Catalog.

Foster Engineering Co.
NEWARK, N. J.

Suppose YOU Were Discharged?

Could you get another job? Would you have to take anything you could get, at whatever they would pay? Or do you possess the special training that qualifies you for a responsible position and a good salary wherever you go?

A man's earning power is rated according to his knowledge of his trade. If lack of such knowledge holds YOU down to an inferior position, your salvation lies in the coupon below. Mark it and mail it to the I. C. S., and they will tell how they can provide you with the training that will enable you to better your position and increase your earnings. It puts you under no obligation to send this coupon.

Can you afford to neglect opportunities for advancement?

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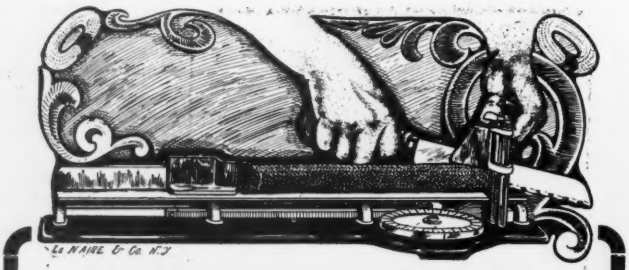
Box 835, Scranton, Pa.

Please explain, without further obligation on my part, how I can qualify for a larger salary in the position before which I have marked X

Mechanical Engineer	Sheet-Metal Draftsman	Surveyor
Mechanical Draftsman	Electrician	Mining Engineer
Machine Designer	Stationary Engineer	Architect
Foreman Machinist	Marine Engineer	Bookkeeper
Electrical Engineer	Civil Engineer	Stenographer
Chemist	Bridge Engineer	Ad Writer

Name _____ *City* _____

Street and No. _____ *State* _____



SOMETHING NEW

The Exacto Packing Gauge and Cutter.

Cuts uniform size rings to fit any sized rod from continuous length packings.

No measuring necessary, no calculations. If you know the size of the rod and the packing to use, that's all you want.

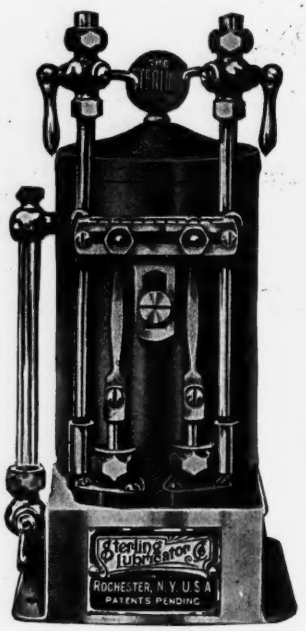
Every ring is clean cut with a true lap joint and the beauty of it, they fit the rod as a ring should fit. Every engineer knows that if packing is properly cut and fitted it will last half as long again as ill-fitting, carelessly cut rings.

Think of the handiness of this device, the saving in time and trouble and the buying of expensive ring packings. Write for our booklet on this device.

GREENE TWEED & CO.
109 Duane Street, NEW YORK

IT Costs You Nothing

to equip your plant with these splendid Lubricators



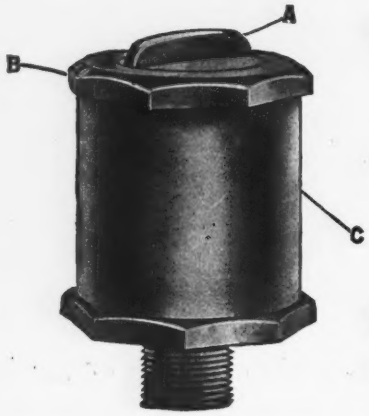
because they pay for themselves in a few months and then save money constantly for years after. How do they do it? Why by doing more work and better work with a pint of oil than any other style of lubricator will do with a quart

The Sterling Lubricator

starts when the engine or pump to which it is attached starts and stops when they stop. There is no waste. It feeds just as much oil as you want it to and no more, you can always see what it is doing. It is the perfect lubricator.

CATALOGUE FREE

Sterling Lubricator Co.
3 Frank Street, Rochester, N. Y.



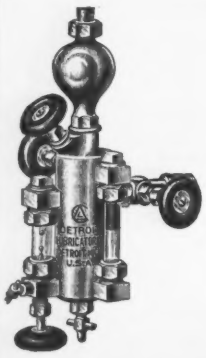
The "Philadelphia" Grease Cup

Automatic Feed By Means Of Compressed Air

This cup is not an experiment. Its success has been thoroughly demonstrated under many conditions, and it has received the highest commendation from a large number of users, not only for its efficiency but also for the large economy resulting. The only automatic cup that positively insures the grease reaching the journal in its original condition and performing its full work without waste.

WRITE FOR FULL INFORMATION

The Philadelphia Lubricator & Mfg. Co., Inc.
1525 Land Title Building, - - Philadelphia, Pa.



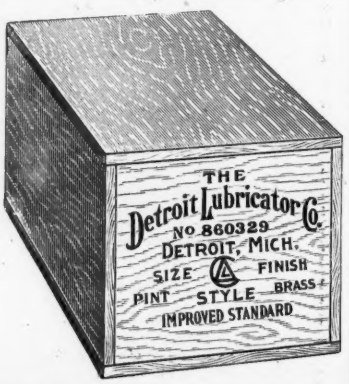
The Detroit Lubricators

Are Standard the world over.

More than 850,000 of them are in use.

Look for the GENUINE ORIGINAL PACKAGE. Catalogue on Application.

Detroit Lubricator Co.
DETROIT, MICH.



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Don't worry your correspondent.

Don't write him anything by hand that akes him time to make out—that may leave him in doubt—that he can't easily read.

And don't fill out legal papers or card memos—or make out accounts in your own handwriting.

It looks bad, reflects on your standing, makes people think you can't afford a stenographer, and is sometimes ambiguous.

You can write out your letters—make out an abstract—fill in an insurance policy—enter your card memos—make out your accounts, or a hotel menu—or do any kind of writing you need, on any kind, size or thickness of paper, and space any way you wan on

The OLIVER Typewriter

***The* Standard Visible Writer**

You can write any of these things yourself if you do not happen to have a stenographer.

For you can easily learn with a little practice, to write just as rapidly and as perfectly, as an expert operator on the OLIVER. Because the OLIVER is the simplified typewriter. And you can see every word you write. About 80 per cent. more durable than any other typewriter, because it has about 80 per cent. less wearing points than most other typewriters.

Eighty per cent. easier to write with than these other complicated, intricate machines that require "humoring"—technical knowledge—long practice and special skill to operate.

Than machines which cannot be adjusted to any special space—with which it is impossible to write abstracts, insurance policies, or odd-size documents except you buy expensive special attachments requiring experts to operate.

You can adjust the OLIVER to any reasonable space—you can write on any reasonable size and thickness of paper, right out to the very edge, without the aid of any expensive attachment or special skill, and your work will be neat appearing, legible and clear.

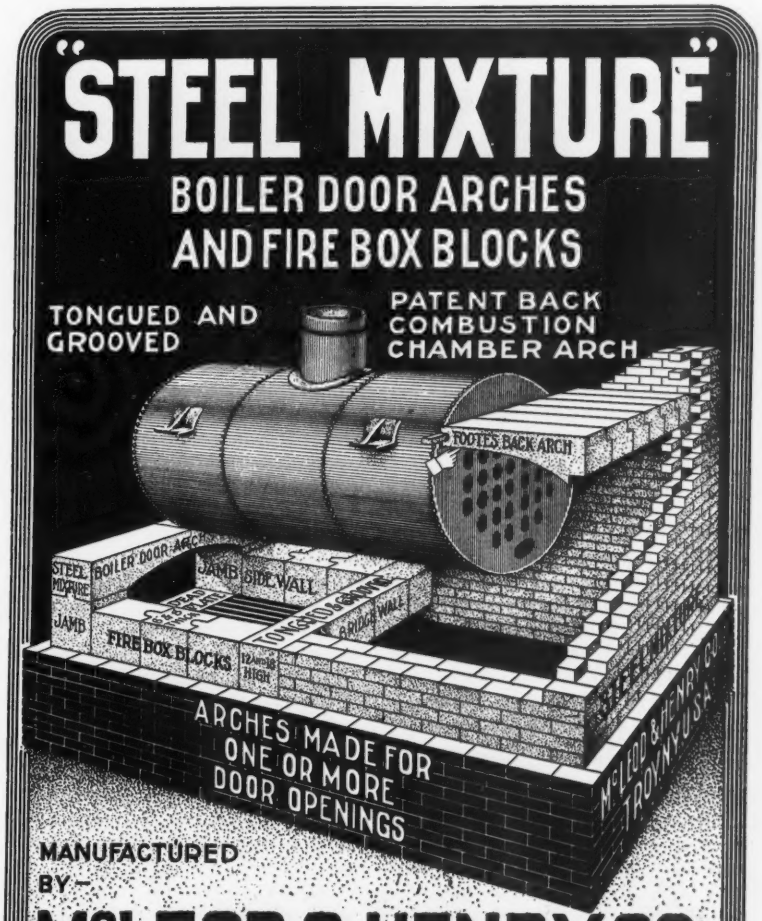
Forthe OLIVER is the typewriter for the doctor, the awyer, the insurance agent, the merchant, the hotel proprietor—or any man who does his own writing.

Write us now for our booklet on the simplified features of the OLIVER.

***The* OLIVER Typewriter Co.**
WALNUT AND TENTH STS.
PHILADELPHIA, PA.

"STEEL MIXTURE"

BOILER DOOR ARCHES AND FIRE BOX BLOCKS



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McLEOD & HENRY CO.

INQUIRIES SOLICITED. TROY, N.Y., U.S.A.

BRANCH OFFICE:—
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1402 BROADWAY—ROOM 1125—KNICKERBOCKER BUILDING—NEW YORK CITY

Walsh Metal Face Packing

A—Fibrous Packing. **B**—Metal.
C—Open space to avoid butting when cover is worn off.
D—Section of metal cut out at C.

Adapted to all kinds of Steam and Water Packing. Will not cut Rods, will not wear rods to shoulder, will not harden under compression. More durable than fibrous packing. Less friction, as it is lubricant of itself. For packing engines, steam hammers, cranes, valves, expansion joints, pumps, elevators, accumulators, hot-water plunger pumps, etc. **Cotton, Linen and Square Flax Packing in Stock.**

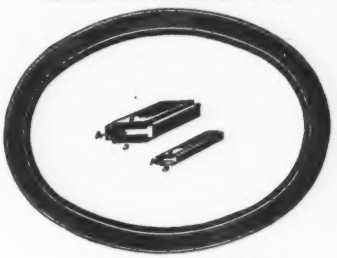
PACKING FOR ELEVATORS a Specialty

Walsh Packing Co.

1118 and 1120 S. Seventh St., Philadelphia, Pa.

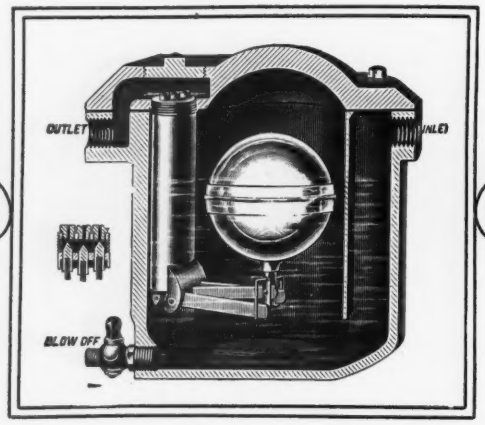
Walsh Combination Gaskets

WILL NOT BLOW OUT



Can be used from 10 to 40 times.
The Cheapest Gasket Made.

A—Soft Metal. **BB**—Rainbow Rubber. Composed of Soft Metal and Rainbow Rubber as shown in cut. Made different widths and thicknesses for man and hand hole Gaskets.



A Wright "Emergency" STEAM TRAP

Disposes of all Condensation

GUARANTEED NOT TO WASTE STEAM

THE **Wright "Emergency"** offers a dependable means of clearing your pipes of condensation on a thoroughly simple and economical principle—**Three Valves** operate as required for a small flow or flood of water—A seal of four to six inches of water at both inlet and outlet makes it **impossible** for this Trap to **waste steam**. Designed to operate up to 250 pounds pressure—we ship on ap roval—send for catalog.

WRIGHT MANUFACTURING CO.
72 WOODBRIDGE STREET, DETROIT, MICH.

The Ashton Quality

POP SAFETY VALVES
RELIEF VALVES
BLOW - OFF VALVES

can be trusted at all times, being of a superior quality and guaranteed to give perfect satisfaction.

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THE ASHTON VALVE CO.
271 Franklin St.
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STEAM AND VACUUM GAGES
RECORDING GAGES

are absolutely accurate and reliable, having non-corrosive movements.

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STEAM TRAPS

of the right sort will pay better returns on the investment than anything you can buy for your steam plant equipment. They will remove the condensation, after the steam has given up its heat units into productive results, and will put this pure soft water into your receiving tank, to be used again in the boiler.

THE DUNHAM TRAP

will do this and more. Thousands in use and proving it every day. Let us send circular "C."

C. A. DUNHAM CO., Marshalltown, Iowa

Resident Manager, L. BANCROFT MELLOR
No. 14 S. Fourth Street, Philadelphia, Pa.

What's *the* Difference?

30-Days Trial will prove that Lindstrom's Liberating Valve **Steam Trap** is a wonder. **The only Successful Steam Trap.**

It takes care of itself.
No parts to get out of order.
The Valve never leaves the Seat.
No Scale can get between Seat and Valve. The Lid is ground, no Packing needed.

Special Discount during the next 2 Months.

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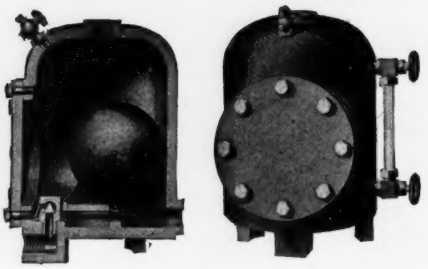

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John T. Lindstrom

214-216 S. Third Street
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STARRETT

Speed Indicator No. 104

Price, Postpaid, $1.00

This Indicator may be run at highest speed required, without heating. The working parts are encased. Dial has two rows of figures, reading either right or left as shaft may run. Steel pointed spindle with rubber tips for both pointed and centered shafts. The O mark may be instantly set at the starting point.

Send for free Catalogue No. 17 N of Fine Tools

THE L. S. STARRETT CO., ATHOL MASS. ,U. S. A.

What's In A Name—Everything

When Steam Fittings are the Topic.

POWELL INJECTOR

If you need an Injector you want a good one and that is the

POWELL AUTOMATIC INJECTOR

Send for sample, you will have no further trouble feeding water to your boilers with a positiveness.

For economy and high standard of efficiency, it BEATS THEM ALL.

A trial will convince you. Send for catalogue and circular describing same.

The **Wm. Powell Co., Cincinnati, O.**

Phila. Depot, 518 Arch St. New York Depot, 51 Cliff St. Boston Depot, Cor. High & Congress Sts.

Any Belt Troubles?

Here is the remedy for slipping and decay.

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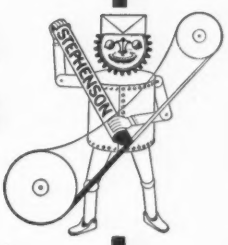
Bar Belt Dressing



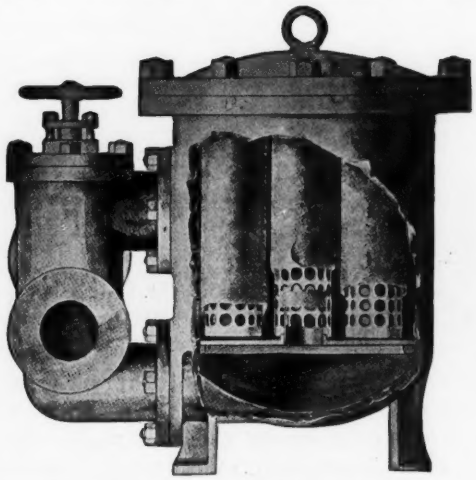
And see how simple it is

No heating beforehand. Friction does that in the very act of applying **STEPHENSON**

Call on your dealer, or send us 2 Cents for Free Sample, stating if for Leather or Rubber Belts. No ONE kind is good for ALL belts.

Stephenson Mfg. Co. Albany, N.Y.

Filtered Feed Water Prevents Scale



The Blackburn Smith Patent Feed Water Filter and Grease Extractor will remove all the mud and grease from your feed water, prevent scale and save you the cost of boiler compounds and wasted fuel. Can be placed either on the suction or discharge scale of feed pump. Easy to clean. Made in all sizes. Write for Catalogue.

Greacen-Derby Engineering Co.

PERTH AMBOY, NEW JERSEY

"Worth Has Won."

The Anderson Cushioned Non-Return Valve.

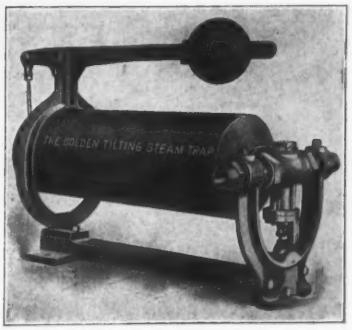
The Anderson Cushioned Non-Return Stop Valve.

"PROTECTS YOUR BOILERS WITH AN ABSOLUTE SAFETY STOP."

Why endanger your boilers by using the regular Angle, Globe or Gate Valves at the boilers, when you can get the ANDERSON Cushioned Non-Return Valve, which is an AUTOMATIC STOP VALVE also a HAND STOP VALVE—All in one:

Possibly we can replace your old valves at the boilers without change of piping.

"We guarantee these valves."



Golden Patent Tilting Steam Trap

THE GOLDEN PATENT TILTING STEAM TRAP

has won for itself an enviable name and reputation. It is a trap of real worth. Simple, positive and durable. It has no floats, valves or buckets inside the trap to cause trouble and expense. All working parts are outside.

We know these traps have no equal

GOLDEN-ANDERSON VALVE SPECIALTY CO.

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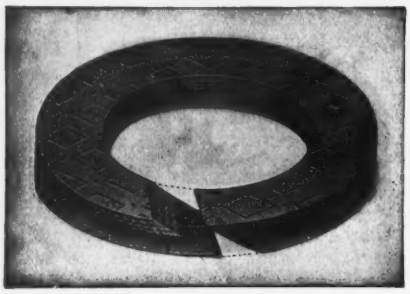
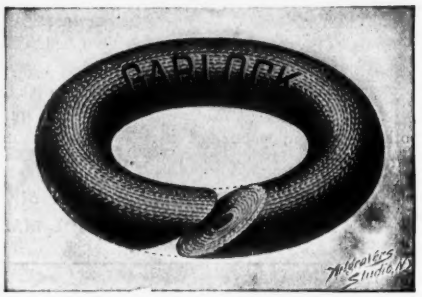
Garlock HIGH GRADE Packings

There are many good reasons for using Garlock Packings in preference to any other brand. One of these reasons that will appeal to busy men is the fact that we can supply a special packing for every kind of service and can furnish you with every thing you need in mechanical rubber goods such as Hose, Pump Valves, Gaskets, Valve Discs, Diaphragms, Corrugated Rubber Matting, Rubber Bumpers, Gauge Glass Rings, and many other specialties.

If you buy from us you have but one rubber goods account, but one catalogue to consult and you have the satisfaction of knowing that the Garlock Guarantee means just what it says.



STYLE No. 285
For Gas Compressing Machines and other service where a high-grade cushion ring is necessary.



STYLE No. 255
For Oil Pumps and similiar service requiring a round tough and elastic packing.

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The GARLOCK PACKING CO.

Main Office:— Palmyra, N. Y., U. S. A.

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Stayman Self-Expanding Pistons

Possess many distinct advantages which make them vastly superior to any other engine pistons. The inner spring ring, shown in cut, expands the interlocking packing ring just enough to insure a steam-tight fit without undue pressure against the cylinder walls. It automatically adapts itself to variations in temperature or unevenness in cylinder. It insures a perfect fit with a minimum of friction. It never gets out of order, never needs adjustment, and will save enough in fuel to repay its cost many times.

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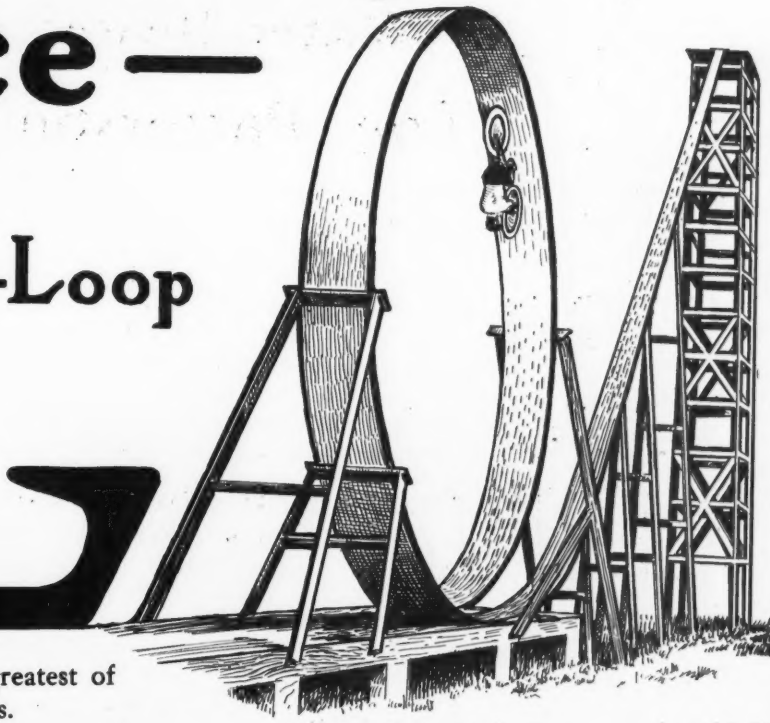
STAYMAN MANUFACTURING CO.

143 Liberty Street, NEW YORK CITY

Centrifugal Force—

the Loop-the-Loop idea



is applied to the greatest of all Steam Separators.

The "Swartwout" Vertical

—the Separator without a fault.

Our "How a good Separator Works" Booklet explains all—you should get it—even supposing you didn't need it for present use—no telling when you may, and you might just as well get posted **now.** Many calculating long-headed men are.

Then why not **you?**

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The Pittsburg Steam Specialty & Engineering Company, Empire Building, Pittsburg, Pa.
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We've a Cast Iron Exhaust Head operating on the same principle as our Separator. Particulars on request.

THE OHIO BLOWER CO.

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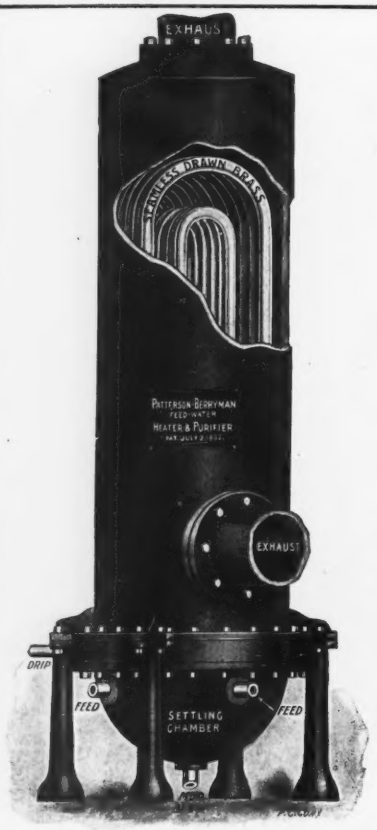

A Penny Saved Is A Penny Earned

You can save dollars in operating your power plant, by installing

The Patterson - Berryman Feed Water Heater and Purifier

You can economize still further by using

The Patterson Belt Pump

They will supply your boilers with pure water heated to the highest temperature obtainable by means of exhaust steam, without back pressure.

We are so confident that you will be pleased with the results obtained by the use of these two machines, that we are willing to ship either or both of them to you on trial with the understanding that they may be returned at our expense should they prove unsatisfactory.

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Frank L. Patterson & Co.
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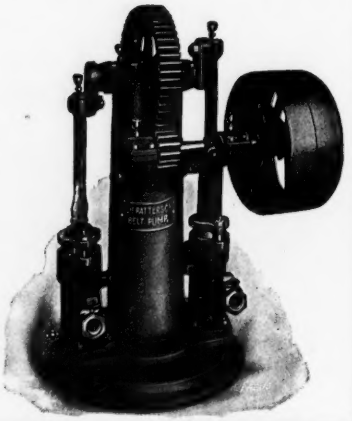

THERE ARE MORE

Compound Separators

used in boilers than all others.

They insure dry steam, and protect your engine from water.

Compound Separator

Boiler Fronts, Grate Bars, Furnace Castings, Compound Separators, and General Boiler Castings

The Kutztown Foundry and Machine Co.

WORKS:

KUTZTOWN, PENNA.

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Berryman

Feed Water Heaters and Purifiers

WATER TUBE AND STEAM TUBE

Cast Iron or Steel Shells. "U" Shaped Seamless Drawn Brass Tubes.

We Build Heaters for every Purpose and Condition

THE KELLEY PATENT

Improved Berryman Water Tube, Feed Water Heater and Purifier

BENJ. F. KELLEY & SON, Makers
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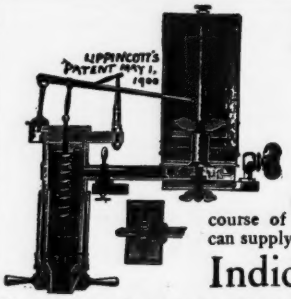


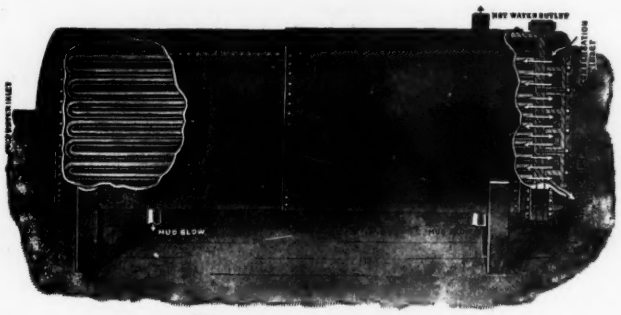
I Can Teach You The Indicator

and in connection with the thorough course of instruction which is given by mail, I can supply you with a fine

Indicator Free of all further expense.

If you want an **Indicator, Reducing Wheel or Planimeter,** don't fail to write me and in addition to the fine catalogue, you will receive a neat premium which you will find useful.

Address A. C. LIPPINCOTT, Gen'l. Manager
Green and Columbia Sts. NEWARK, N. J.



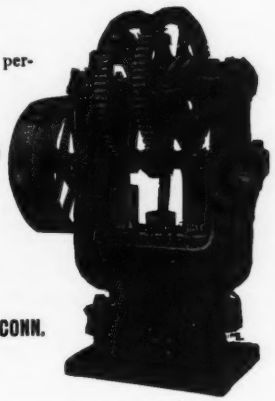
The Gleaner TRADE MARK

The **Gleaner** represents the acme of perfection in feed water heating.

THE

Davis Triplex Power Pump

is a perfect type of the vertical triplex belt driven pump.



MANUFACTURERS OF
The "Berryman" Feed Water Heater and Purifier.

I. B. DAVIS & SON, HARTFORD, CONN.

WRITE FOR CATALOGUE, ETC., TO

THOS. McADOO, 125 N. 4th St., Philadelphia

Foaming— Priming— Water in the Steam—

Do your boilers foam or prime, or is there excessive moisture in the steam?

Have you long or exposed lines of piping, or do you have difficulty in getting sufficient steam to your engines because of piping that is too small?

For such cases Cochrane Receiver Separators possess special advantages. Their large receiver wells enable them to take care of excessive quantities of water until the trap or other drainage device has time to act.

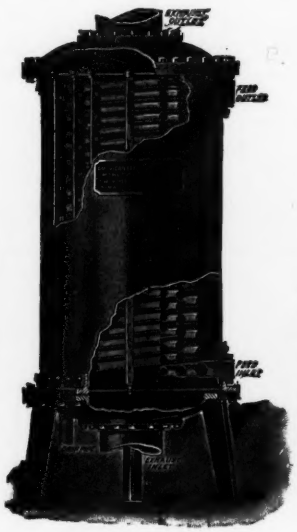
These receiver wells also serve as a steam receiver close to the engine, into which the steam flows continuously—instead of intermittently as the engine ports open and close—and upon which the engine can draw instantly.

The continuous flow of the steam also prevents hammering and vibration in the piping.

Our catalogue 16-S fully describes and illustrates these Cochrane Receiver Separators.

HARRISON SAFETY BOILER WORKS
3144 N. 17th St. PHILADELPHIA, PA.

The American Standard Copper Coil Feed Water Heater



Simplicity!
Strength!
Economy!
A Money Saver!

It gives so little trouble that one of our customers, who has used one for three years, had forgotten that he had it when we asked him the other day how it was doing. He called in the engineer, who said it hadn't been touched since it was put in and was still heating the water to 210 degrees.

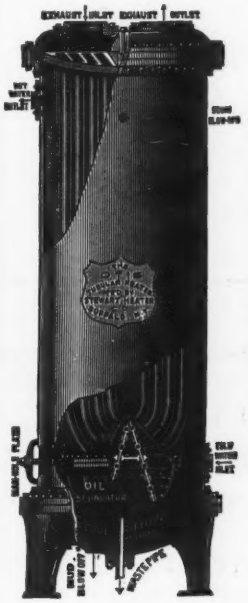
THAT.S THE KIND OF A HEATER YOU WANT.

Write for Catalogue No. 100 P

The Whitlock Coil Pipe Co.

HARTFORD CONNECTICUT

The OTIS



Feed Water Heater, Oil Separator and Purifier is the best oil separator as well as the best feed water heater made. When you buy an Otis you buy satisfaction or you get your money back! and we pay the freight and cartage both ways.

The arrangement of the tubes; the water and oil separator and the cool settling chamber are features that will be appreciated at once by every experienced engineer.

The location of the connections; the "travel" of the exhaust and the ease with which it can be cleaned are features of equal importance.

We Guarantee to heat the feed water to the boiling point (210 or 212 degrees) with the exhaust without causing any back pressure, also to extract the oil from the exhaust

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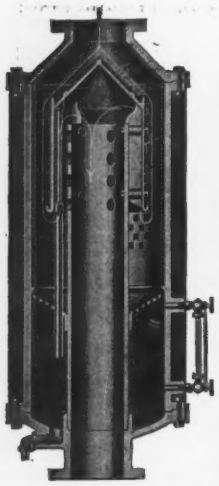
11 Norfolk Avenue BUFFALO, N. Y.



Sweet's Separators

When considering the Separator subject, please let us send our catalog and blue prints; look up the dimensions, weights and proved efficiencies of our machine, compare them with others and see if we don't furnish the most for the money; then consider the **plan** and **finish** of our separators; see if the plan is such that **you think** it will give the results claimed. Made in all styles, for steam or oil.

SEND FOR CATALOG. ALL STYLES.

Direct Separator Co.

220 Marcellus Street

Syracuse : : New York

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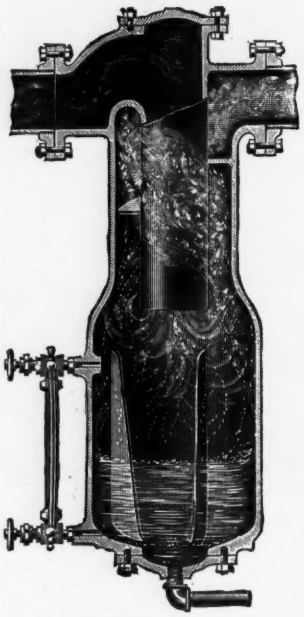
THE BENJAMIN F. SHAW COMPANY, Wilmington, Del.

THE STRATTON Steam Separator



Will deliver **Dry Steam** to your engine under any and all conditions, no matter how long your steam pipe or how much your boilers may prime.

Separation takes place by the action of centrifugal force imparted to the steam. The large capacity not only provides for a sudden influx of water but forms a reservoir of steam which equalizes the pressure between boiler and engine, thereby increases the power and stops the vibration of steam pipes; a separator of small capacity is worse than useless, it is harmful.

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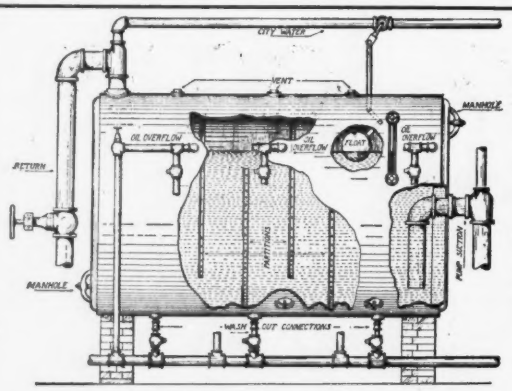
The Goubert Mfg. Co.

85 Liberty Street, NEW YORK

WORKS BAYONNE, N. J.



PATENTED JAN. 10, 1905

Your Heating System

may have developed some defects during the past winter, perhaps its efficiency was not as high as you desired on those few coldest days, or perhaps you have discovered that you are blowing a lot of water, oil and heat out into the sewer.

THE McKNIGHT RECEIVER AND OIL SEPARATOR

will receive all the discharge from your steam traps and all the condensation from your entire heating system and will separate all oil and grease from the water so that both the water and the oil is purified and can be used over again. Its use will improve the entire system and save many times its cost. Write for Circular and Prices.

Walter J. McKnight, 179 WASHINGTON ST. BUFFALO, N. Y.

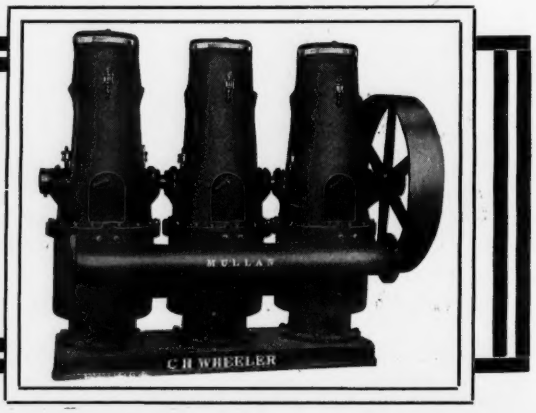
Mullan Suction Valveless Air Pump

Maintains the highest Vacuum under all conditions.
Vertical and Horizontal, Single, Duplex and Triplex Designs.

C. H. Wheeler MANUFACTURING Co.

PHILADELPHIA

26 Cortlandt St. NEW YORK | 184 Washington St. CHICAGO | 151 Tremont St. SAN FRANCISCO



The Acton Steam Separator and Oil Extractor

This Separator represents the latest and most valuable improvements yet discovered. It will take out 95 per cent. of the oil and condensation.

The only Separator that can be cleaned. Take off the top, remove the basket, clean it, replace it and you have a new Separator.

WRITE ME.

JOHN ACTON

118 John St., Brooklyn, N. Y.

The Baum Separator

Horizontal Style for live Steam or Oil Service.

For Live *and* Exhaust Steam
RESULTS GUARANTEED

Repeat orders are the best evidence of satisfactory results on the part of a satisfied customer.

"We are using the second Baum Separator and are very much pleased with the results we are getting from it," writes one who has been using Baum Separators for several years.

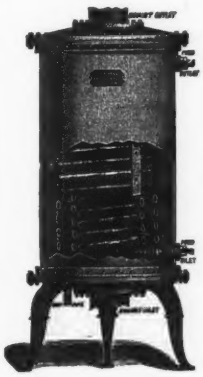
Write for further information before placing order. A new catalog on request.

The Baum Separator and Machine Co., MANHEIM, PA.

Vacuum Style Oil Extractor.

The National Feed-Water Heater

2,500,000 Horse Power in Daily Use



The National

The principal characteristics of these heaters are *Simplicity, Cheapness, Reliability and Effectiveness,* and full amount of heating surface in every heater.

Supplies Water to the Boiler at 212° F.

We manufacture the Original and Only Genuine First-Class Coil Feed-Water Heaters.

We Also Manufacture All Kinds of Coils in Iron, Brass and Copper Pipe

Catalogue and Prices on Application.

Manufactured and Sold Only by

THE NATIONAL PIPE-BENDING CO.

157 Lloyd St. NEW HAVEN CONN.

THE GEMMEL PATENT BOILER

JAMES GEMMEL

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This Vertical Boiler possesses all the advantages of a Horizontal Boiler and none of its expensive disadvantages.

It requires only small floor space. It requires no expensive setting. It affords a natural path for the flue gases, and is a rapid steamer.

Its improved construction guarantees rapid circulation, and the highest degree of efficiency.

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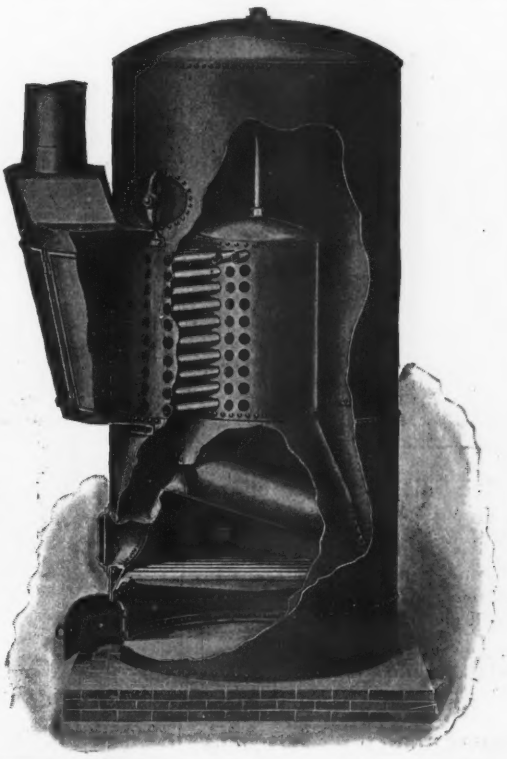

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MACHINE BLACKSMITHING.

Machinery Repairs—Cylinders of Engines and Pumps Rebored in place. Stacks, Tanks and all kinds of Boiler Work.

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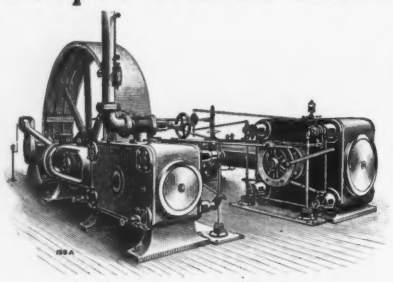

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Complete Equipments for Ice Manufacture.

Entire Installation of Mechanical Refrigerating Systems for PACKING HOUSES, BREWERIES, COLD STORAGE WAREHOUSES

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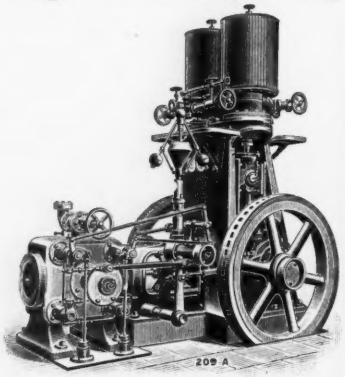
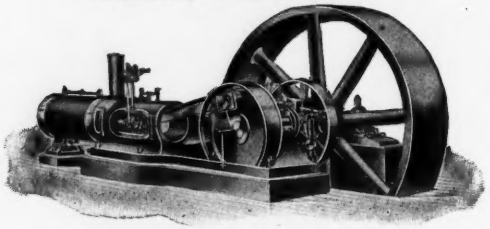


FRICK COMPANY, Waynesboro, Pa., U.S.A.

BUCKEYE ENGINE Co.

SALEM, OHIO, U.S.A.



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THE LARGEST LINE OF MODERN ENGINE PATTERNS IN THE WORLD.

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FOR ALL SERVICES

Finest Mechanical Design and Construction

Material and Workmanship first class in every respect.

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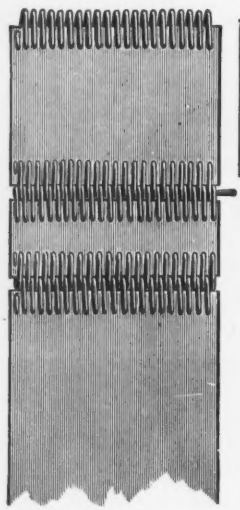

Look at that Lacing a minute—isn't that well done?

Well you can lace a 5-inch belt this way in less than 3 minutes at a cost of one cent for the lacing if you'll get a

Jackson Belt Lacer

AND MIND YOU—

This joint is just as pliable as any other part of the belt.

The shortening or lengthening of a belt when laced in this manner is but the work of a few seconds.

Think this over and write—

Birdsboro Steel Foundry and Machine Co.

BIRDSBORO, PENNA.

GET ONE FREE

Put it on your boiler, and give it a good trial for a month; if it gives you absolute satisfaction, keep it, and pay for it, otherwise send it back at our expense.

"P. B. H." WEIGHT GAUGE COCK

There is but ONE renewable part; the special metal valve pencil, which lasts for years and can be replaced for a few cents, in a minutes time. Thousands in use. Absolute satisfaction on high pressures.

THE PAUL B. HUYETTE CO., Inc. 1245 BETZ BUILDING PHILADELPHIA

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YOU HAVE ELEVATOR TROUBLES. WE HAVE EXPERIENCE. LET'S SWAP.

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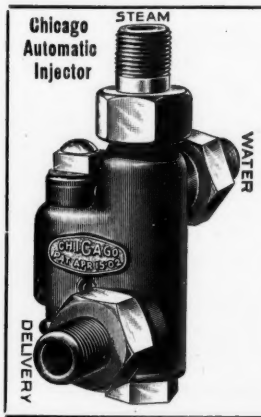


Chicago AND Garfield

INJECTORS are today made as strong, heavy and with as much care as when metals were low. You are taking no chances when your boilers are equipped with them.

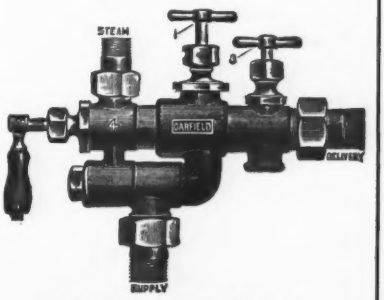
A user of our Injectors of Wanakena, N. Y., writes that he has used one of them for sixteen years and it is still giving satisfaction. This shows how well they are made.

We have a complete line of Injectors, Ejectors, Lubricators, etc., for stationary and locomotive service. Ask your dealer for them.

CATALOGUE FREE

The Ohio Injector Co.

2128 MAIN STREET WADSWORTH, OHIO



Garfield Double Jet Injector

U.S. Automatic Injector

Starts at 15 lbs. on a 2 foot lift

The wide range of the U. S. Automatic Injector is but one of the features which make it the most desirable injector on the market—and remember that the range and capacity of the U. S. Injector is **guaranteed.**

Each U. S. Injector is carefully tested before leaving the factory, and the result of this test shown on the guarantee card which accompanies it.

The U. S. Automatic Injector is the one Injector with a Drop-Cock and has a score of other important advantages over other Injectors, all of which are carefully explained in the **"Engineers' Red Book."** Sent **free** to all who write. Contains also over 500 points of interest to every engineer. Is invaluable. Write for a copy today.

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Injectors and Engine Room Specialties
Are upheld by over 450,000 engineers as the standard automatic injector of the world.

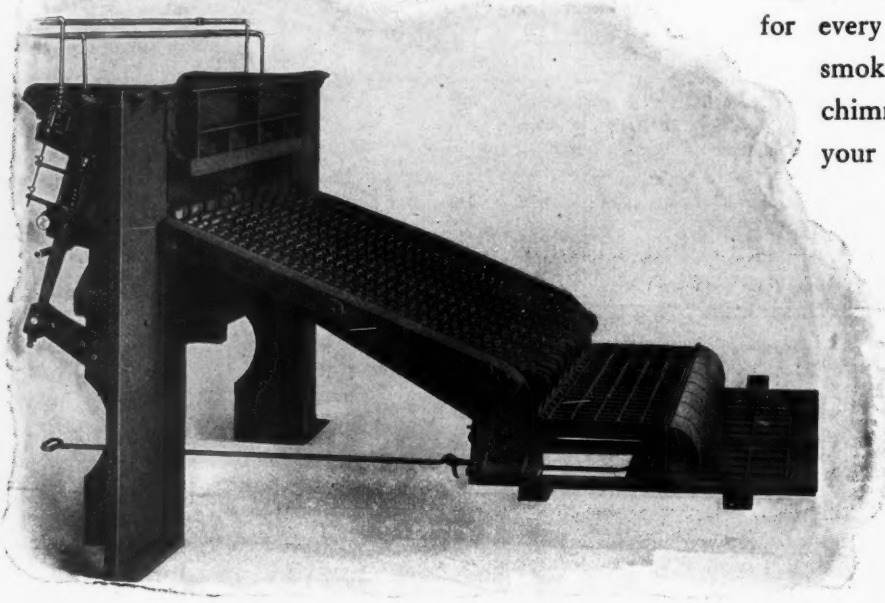
Penberthy water gages, gage cocks, oil and grease cups, injectors, oil pumps, etc., maintain the high standard of excellence which the name of PENBERTHY stands for.

The Penberthy Bulletin, a 32-page monthly magazine for engineers, sent 3 months free on request. Write for our catalog for engineers.

PENBERTHY INJECTOR CO.
Largest Manufacturers of Injectors in the world.
344 Holden Ave., Detroit. Mich.

Protect YOUR Coal Pile

Every particle of black smoke that goes up your chimney means dollars to the winds, and dirt in your neighbors windows.



A smoky chimney is a nuisance in any neighborhood and mighty costly to its owner, for every particle of the smoke that goes out the chimney to smut up your buildings and torment your neighbors represents good fuel going to waste—fuel that could be burned and converted into heat if your plant was equipped

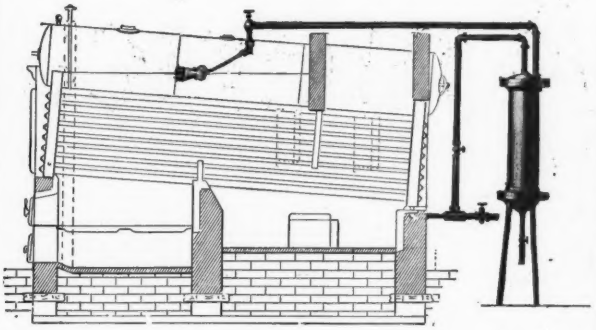
With Wilkinson Automatic Stokers

If you have Wilkinson Stokers you will have no black smoke because the Wilkinson burns all the fuel and gives you the full benefit. It doesn't permit part of it to escape up the chimney and send another part to the ashpit.

How does it do it? Why, it feeds the fuel constantly, regularly, and always in small quantities as required without opening the fire doors. Doesn't it look reasonable that the results would be better than by any other method?

Wilkinson Mfg. Co.

Bridgeport, Montgomery County, Pa.



KEEP IT OUT

SOME STEAM USERS allow the scale to accumulate in their boilers until it is one-fourth inch thick, or more; then buy an expensive machine to grind or pound it out; pay for extra help to work the machine and all the while that the scale was forming they paid for extra fuel to penetrate it.

OTHER STEAM USERS prevent the formation of scale or dissolve it as rapidly as it forms by a constant application of chemicals which are sometimes good; oftimes bad and always everlastingly expensive.

UP-TO-DATE STEAM USERS keep their boilers as clean as when they were new, prevent foaming and get pure steam throughout their entire system thus saving in repairs and increasing the efficiency of the entire plant, for less cost than either the expensive machines or the dangerous and expensive chemicals by adopting the

Buckeye Automatic Boiler Skimmer

In this device the word automatic means something; the **FLOATING SKIMMER** is always at the water level and always working. It removes all the scale forming impurities **AUTOMATICALLY.**

HUNDREDS OF THEM IN USE AND EVERY USER DELIGHTED WITH THE RESULTS

We install them on trial and guarantee absolute satisfaction or no pay. After a trial you will not permit us to remove them.

Our large new Catalogue tells the whole story. WRITE FOR IT.

The Buckeye Boiler Skimmer Co.
COLBURN AVE., TOLEDO, OHIO

HARRIS OILS *YOURS for better RESULTS*

The Efficient and Economical Operation of your Plant depends on the quality of the lubricants you use. For best results you must use only the Best Oils.

To meet the requirements of lubrication relative to pressure, temperature, moisture, etc., in the cylinder of your engine, try HARRIS VALVE OIL expressly prepared for cylinder lubrication. It is absolutely free from grit, acid or gummy elements with the necessary high flash point, to resist volatilization, it has sufficient adhesiveness to ensure the maintenance of a lasting anti-friction film between the closest fitting surfaces under any pressure. Feeds freely and uniformly at any temperature with force-feed, automatic or gravity lubricating systems.

Special Harris Valve Oils are made to meet the exceptional conditions existing in high pressure cylinders, in engines using superheated steam, in gas or gasoline engines and for slow moving low pressure engines, pumps, etc.

HARRIS ENGINE OIL

comes nearest to an all-round lubricant for external parts of engines of all types, for transmission and general machinery at all seasons.

Do you want to know what Harris Oils will do for your plant? Send us word what it consists of, how much oil you use and the kind, we will send you our catalog of Harris Oils and a proposition that will enable you to test them on your own engines and machines.

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TRADE MARK

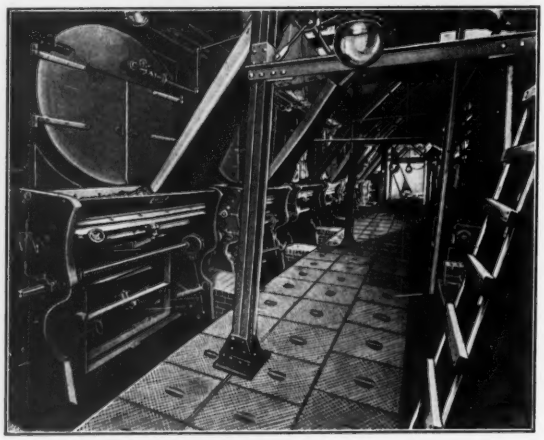
the "Empire" trade-mark is recognized by experienced engineers as a protection against inferior packing. It is stamped in red on every few feet of the genuine

"EMPIRE" Gum Core PACKING

All other braided packings having a rubber core are imitations of the original "EMPIRE" —imitations in every thing except QUALITY and RESULTS. Ask your supply man.

CANFIELD MANUFACTURING CO., Ltd. Philadelphia, Pa.

AN UP-TO-DATE PLANT



No steam plant is up-to-date until it is equipped with Mechanical Stokers. Hand firing at its best is wasteful, and the frequent cold drafts when the fire doors open are injurious to the boilers.

WETZEL MECHANICAL STOKERS

save their cost quickly and pay big interest on the investment. They eliminate black smoke and produce uniform power at greatly reduced cost.

WRITE FOR CATALOGUE AND COMPLETE INFORMATION

The Wetzel Mechanical Stoker Co.
147 East State Street, TRENTON, N. J.

YOU CAN SAVE NINETY PER CENT.

All boiler compounds are composed of approximately the same combination of chemicals. These chemicals can be obtained anywhere at a trifling cost and the mixing of them is a simple matter.

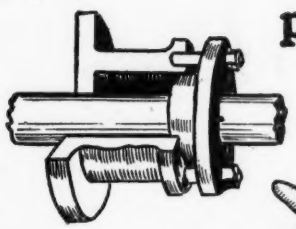
We will sell you the formula for making "Perfection Boiler Compound" and you can make it yourself and save about ninety per cent.

PERFECTION BOILER COMPOUND

never fails to give satisfactory results, we manufacture it for sale and guarantee perfect results or no pay. Those wishing to purchase the formula for making it may order a barrel of the compound first and test it before buying the formula. Write for circular and list of testimonial letters.

The Consumers Supply Co.
18 Marzetti Building COLUMBUS, OHIO

How often do you pack the Stuffing Box?



Perhaps every week.

Probably you are never free from stuffing box troubles. Packing the stuffing box is hard work. It's about the hardest work you have to perform. You know it is. It means working after hours and Sundays too, and you'll always have to perform this hard work unless you change your packing and use

P. P. P. Rod Packing

With P. P. P. you pack a stuffing box once. It doesn't wear out in a day—a week—or a month like the old style solid packings—or worthless imitations of P.P.P. That's because the sliding wedges protect P. P. P. from excessive friction, which grinds the life out of old style solid packings.

A year later you'll probably find P. P. P. just as fresh and good as the day it was packed. When in time P. P. P. does show signs of wear, place in a new ring and screw up the gland with your fingers. That's the pleasant P. P. P. way of packing a stuffing box.

See that coupon? Mail it to us to-day. We'll prove to you that P. P. P.—real P. P. P.—not only saves you work, but saves fuel and power.

Quaker City Rubber Co.
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The **Quaker City Rubber Co. Philadelphia**

Gentlemen :—Please send me your booklet proving that P. P. P. will save work.

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Practical Engineer

DANIEL W. PEDRICK.
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L. B. FLANDERS MACHINE WORKS.
ESTABLISHED 1870.

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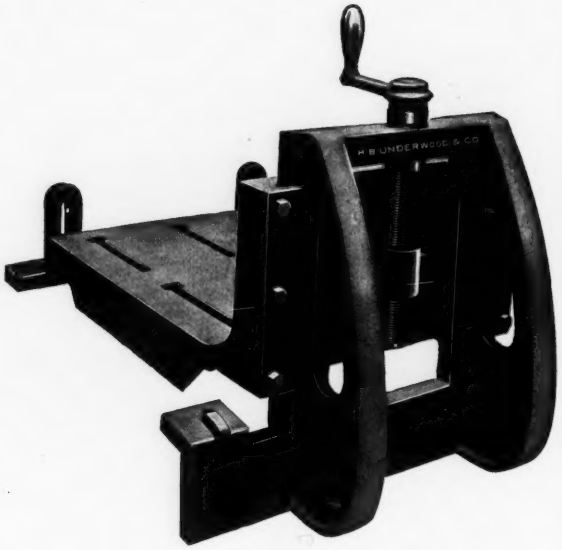
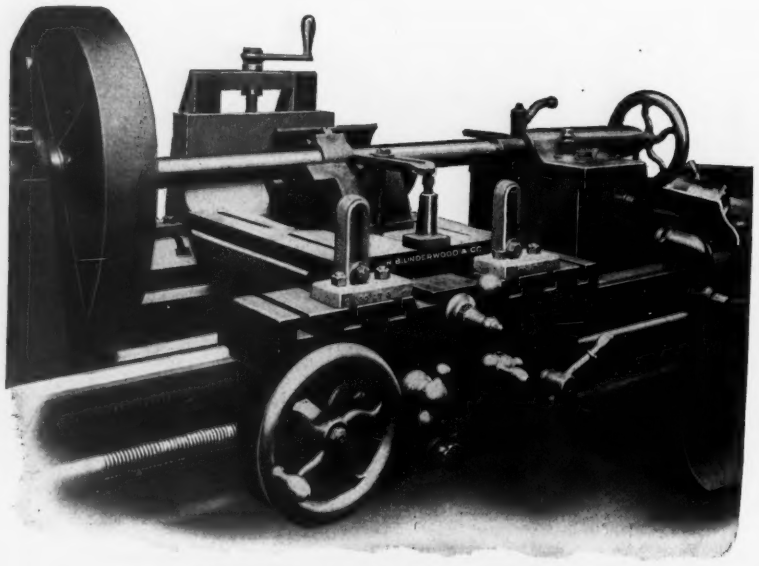
GENERAL MACHINISTS.
1025 HAMILTON STREET PHILADELPHIA, PA.

Boring Attachment For Lathe



THIS attachment is for the purpose of practically converting a lathe into a horizontal boring mill, and when so converted the lathe is equal within its range the output of a mill both in quality and quantity. The attachment which we here illustrate can be made for any size lathe. It consists of a lower plate with an angle projecting down and fastened to the back of the carriage. The surface of this angle plate is planed true with all the other parts of the attachment. The fastening device has a slide well fitted and planed true; it also has an adjusting screw for elevating the bed for holding the work.

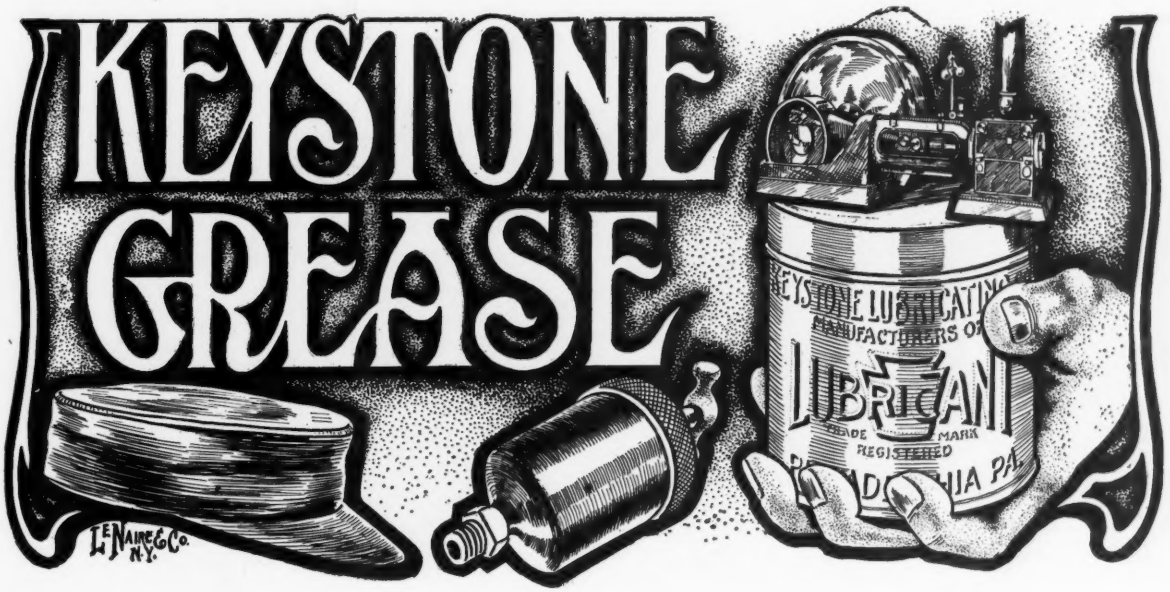


LATHE WITH ATTACHMENT IN SERVICE

When set on the lathe carriage, it is true with the carriage in all directions.

It takes a very short time to make the change for boring; all that is necessary is to remove the tool slide, and drill and tap two holes in the back of the carriage, lift the device on, and in a few minutes it is ready for work.

Write for Circular and Prices.



"*The* World's Greatest Lubricant."

Some lubricants may possess one good quality or another, but no lubricant used for machinery lubrication combines all these good qualities together with others, in one consistent body, that will not lose any lubricating value with age, or will not spoil in any climate, but KEYSTONE GREASE.

No other lubricant will do as much or last as long. No other lubricant is more cleanly. One pound of Keystone Grease will lubricate better and last longer than 3 to 4 pounds of any other grease, or 4 to 6 gallons of high-grade oil.

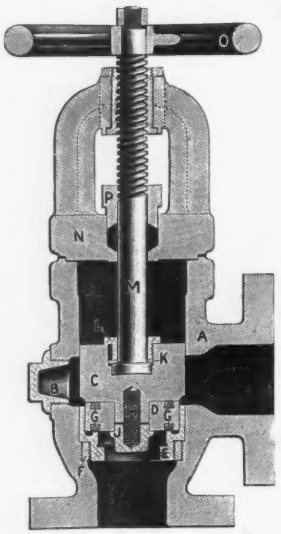
Is it not enough to warrant us in saying it is "*The World's Greatest Lubricant.*" You may prove this if you will, as we send FREE (no charge now or afterward) a Large Sample Can of Keystone Grease, a Heavy Brass Grease Cup and an Engineers Cap, to any engineer sending us his name and business address, size of tap in which cup is to be used, H. P. of engine and R. P. M.

Keystone Lubricating Co.

ADDRESS DEPT. F.

PHILADELPHIA, PA., U. S. A.

LUNKENHEIMER
"Duro" Blow-Off Valve



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RENEWABLE, REVERSIBLE DISC.

SELF-CLEANSING SEAT

THE SEAT AND ALL OTHER WEARING PARTS EASILY RENEWED

Body and Yoke made of a Superior Grade of Hard—Close—Grained Iron, all Wearing Parts made of the Highest Grade of Bronze Composition

If Your Local Dealer Cannot Furnish them, Notify us

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Largest Manufacturers of High-Grade Engineering Specialties in the World.

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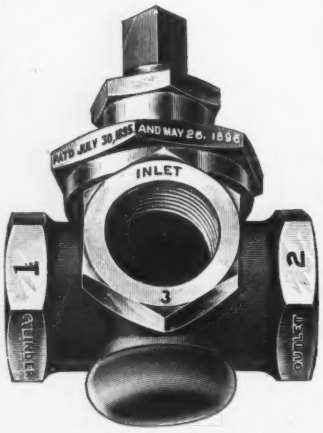
We Manufacture a Complete Line of Brass and Iron Globe and Gate Valves, Mechanical and Hydrostatic Lubricators, Oil and Grease Cups, Injectors, Ejectors, Whistles, Water Columns, Gauges, Pop Safety and Relief Valves, Etc. 4 P. E.

HOMESTEAD
Three Way Valve



with internal locking device requiring one-third turn of plug to lock at both ends of turn, for any pressure. Largely used in steel mills and other plants.

Homestead Three-Way Valve.

This is the best Three-Way Valve on earth.

Homestead Valve Manufacturing Company

Brass Founders

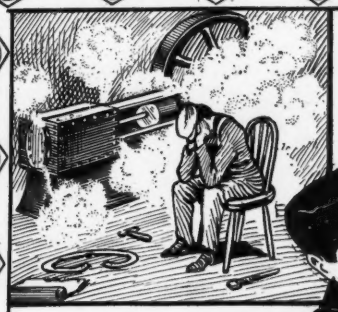
P. O. Box 1754 Pittsburg, Pa.

Works at Homestead, Pa.

One of these Four-Way Metallic Valves was opened and closed 9,125,000 times.

A one and one-fourth inch Homestead Four-Way valve used in operating a blast furnace at the Duquesne Mills was in constant service nights and days and Sundays for over four years without a repair. During that time it was opened and closed 9,125,000 times.

Write for Illustrated Catalogue



INDESTRUCTIBLE WHITE SHEET PACKING

OH FOR A FLANGE PACKING THAT WILL NOT BLOW OUT.

HERE YOU ARE OLD MAN, INDESTRUCTIBLE DONT BLOW OUT. USE IT AND FORGET THE PAST.

MANUFACTURED AND PATENTED EXCLUSIVELY BY

NEW YORK BELTING & PACKING CO., LTD.

91 AND 93 CHAMBERS STREET, NEW YORK.

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KEYSTONE GREASE

The World's Greatest Lubricant

will help keep your hands off the throttle valve longer than any other machinery lubricant made. You won't have to shut down for want of proper lubrication if you use KEYSTONE GREASE.

Why? Because the sum and substance of proper lubrication must be purity of the lubricating agent applied, and Keystone Grease is nothing more than a purified oil made unctuous by a process which eliminates all foreign substance, leaving only that which lubricates.

Speed, pressure, temperature make no difference in the lubricating value of KEYSTONE GREASE.

Will you not accept, with our compliments,—an engineer's cap, a heavy brass grease cup, and a large sample can of Keystone Grease, at our expense FREE of cost now or afterward? All we ask is engineer's name and business address, size of tap in which cup is to be used, H. P. of engine and R. P. M., and his assurance that he will give Keystone Grease a thorough trial.

KEYSTONE LUBRICATING CO.

Address Dept. F. - - - - Philadelphia, Penna.

H. L. CARPENTER, N. E. Mgr.
30 Oliver Street, Boston, Mass.

MR. WM. CAMPBELL, Mgr. Western Branch
1102 Tacoma Bldg., Chicago, Ills.

CUP is free

CAN is free

CAP is free

TO ENGINEERS